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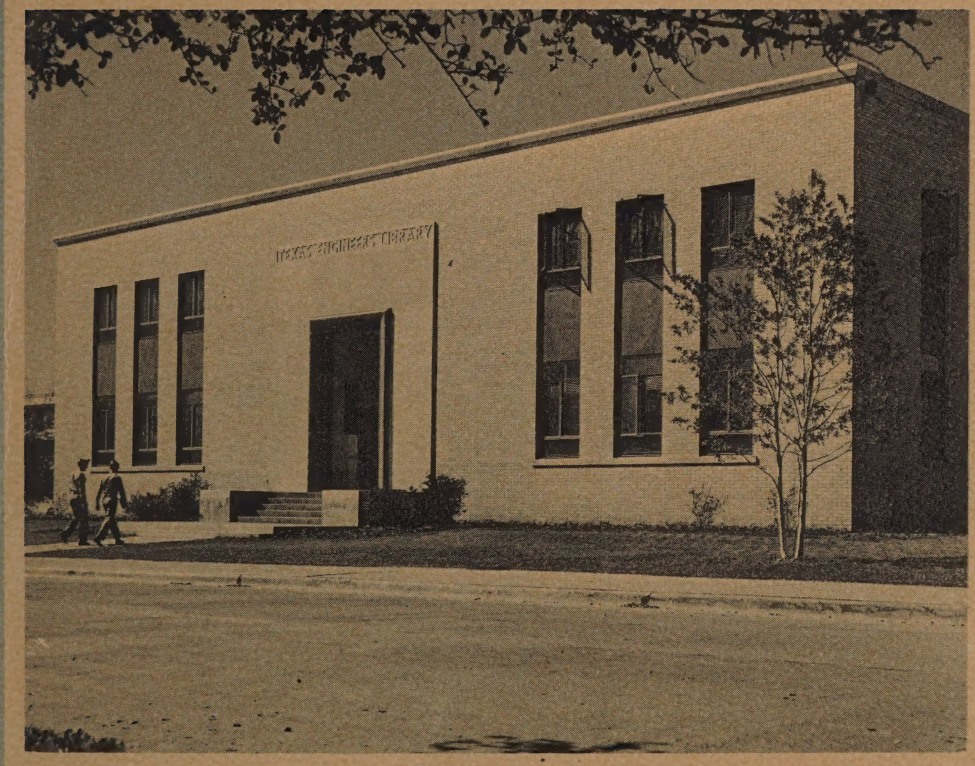
TEXAS Highways



November, 1953

About the Cover . . .

Pictured on the cover this month is the new Texas Engineers Library Building at College Station. The library was moved into its new building in the late fall of 1952. The collection contains more than 13,000 books and more than 10,000 bound and unbound volumes of periodicals. The Library currently receives over 700 scientific and technical periodicals.

It was established by specific authority of the Forty-seventh Legislature and is operated as a cooperative project of the State Board of Registration for Professional Engineers and A & M College.

VOL. I

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TEXAS HIGHWAYS

The purpose of this publication, "Texas Highways," is to furnish a medium for presenting practical ideas and information. Employees are invited and urged to submit suggestions and relate experiences which would benefit or be of interest to Highway employees. These conclusions and data are not necessarily endorsed by the Highway Department nor are they to be construed as instructions.

Photographic services are available and other assistance may be obtained, if desired, in preparing material for submission. All material and comments should be directed to the Information and Statistics Division, Austin 14, Texas.

"Texas Highways" is published monthly by and for State Highway Employees for departmental use only. The use or reproduction of the material contained herein is prohibited without the expressed permission of the State Highway Engineer. This bulletin is reproduced by Operations Division, Reproduction Section.

COMPILED AND EDITED
Information and Statistics Division

Twenty-Seventh Annual Short Course

in

HIGHWAY ENGINEERING

TO BE HELD AT

COLLEGE STATION, TEXAS

UNDER THE DIRECTIONS OF THE

School of Engineering

DEPARTMENT OF

Civil Engineering

OF

The A. & M. College of Texas

AND IN COOPERATION WITH THE

State Highway Department of Texas

SEPTEMBER 30 AND OCTOBER 1

1953

GENERAL INFORMATION

Purpose.—The purpose of the course offered by the Texas A. & M. College is to bring together the engineers, contractors, officials, and others who are interested in the street and highway problems of Texas, in order that they may not only hear various phases of these problems discussed by experts of state and national reputation, but also that they may have an opportunity to meet with each other and exchange ideas.

The Course.—The Short Course will cover a period of two days, the program beginning on Wednesday, September 30, 1953, and ending Thursday, October 1, 1953 at 12:00 noon.

Fees.—There will be a registration fee of two dollars.

Discussion.—Discussion is essential to the success of the course and those in attendance are urged to enter discussions to the extent that time will permit.

Quarters.—Registrants will be housed at hotels in Bryan (5 miles north of College Station) at the Memorial Student Center on the College Campus, and in College dormitories. Several tourist courts are also available in Bryan and at College Station.

Reservations.—Requests for reservations should be mailed directly to Fred J. Benson, Professor of Civil Engineering, College Station, Texas or to John E. Blair, District Engineer, Texas Highway Department, Bryan, Texas.

Program Committee.—The program for the Twenty-seventh Annual Highway Short Course was arranged by the Texas Highway Department Short Course Committee:

Thomas C. Collier, Chairman
Jed N. Robinson
H. L. Arno

and for Texas A. & M. College:

Professor Fred J. Benson,
Director of the Highway Short Course

Administration.—The Highway Short Course is one of the yearly activities of the Civil Engineering Department and is given in cooperation with the Texas Highway Department.

A business meeting of the District Engineers and other Texas Highway Department officials will be held on Tuesday, September 29, in the Ballroom of the Memorial Student Center. Registration for the Short Course for those attending this meeting will be held in the Lounge of the Memorial Student Center from 8:00 a.m. to 10:00 a.m.

PROGRAM

All meetings in Ballroom, Memorial Student Center

WEDNESDAY, SEPTEMBER 30, 1953

Morning

8:00 Registration, Memorial Student Center

Chairman: Dr. S. R. Wright, Head
Civil Engineering Department
Texas A. & M. College
College Station, Texas

10:15 Invocation
Rev. Robert D. Longshore
First Baptist Church
College Station, Texas

Address of Welcome
M. T. Harrington, Chancellor
Texas A. & M. College System
College Station, Texas

10:30 Response
D. C. Greer, State Highway Engineer
Texas Highway Department
Austin, Texas

10:45 Selected Subject
E. H. Thornton, Jr., Chairman
Texas Highway Commission
Galveston, Texas

Selected Subject
Marshall Formby, Member
Texas Highway Commission
Plainview, Texas

Selected Subject
Robert J. Potts, Member
Texas Highway Commission
Harlingen, Texas

Remarks on Transportation Research
Thomas H. MacDonald
Distinguished Research Engineer
Texas A. & M. College

Afternoon

Chairman: D. T. Harkrider, Director
Motor Vehicle Division
Texas Highway Department
Austin, Texas

2:00 Right of Way Problems
L. B. Dean, District Engineer
Texas Highway Department
Wichita Falls, Texas

2:30 The District Safety Council
R. E. Lindsey, Director
Insurance Division
Texas Highway Department
Austin, Texas

3:00 The District Laboratory
Frank S. Mitchell
Laboratory Engineer, District 12
Texas Highway Department
Houston, Texas

3:20 Discussion
A. W. Eatman, Engineer
Materials and Tests
Texas Highway Department
Austin, Texas

3:30 Floor Discussion

7:00 Annual Banquet
Sbisa Hall

Toastmaster: Wick Fowler
Executive Assistant to the Governor
Austin, Texas

Speaker: D. X. Bible
Athletic Director
University of Texas
Austin, Texas

THURSDAY, OCTOBER 1, 1953

Morning

Chairman: D. C. Greer, State Highway Engineer
Texas Highway Department
Austin, Texas

9:00 Urban Highway Surveys
George S. Meyer,
Senior Resident Engineer
San Antonio Expressway Project
San Antonio, Texas

9:20 Discussion
O. G. Rayner, Supervising Urban Engineer
Dallas Expressway Project
Dallas, Texas

9:30 Floor Discussion

9:45 Intermission

10:00 Prestressed Concrete
James R. Graves, Senior Designing Engineer
Bridge Division
Texas Highway Department
Austin, Texas

10:30 Discussion
B. A. Trice, Vice-President and Chief Engineer
Harry Newton, Inc.
Graham, Texas

10:45 Discussion
P. V. Pennybacker, Supervising Field Engineer
Bridge Division
Texas Highway Department
Austin, Texas

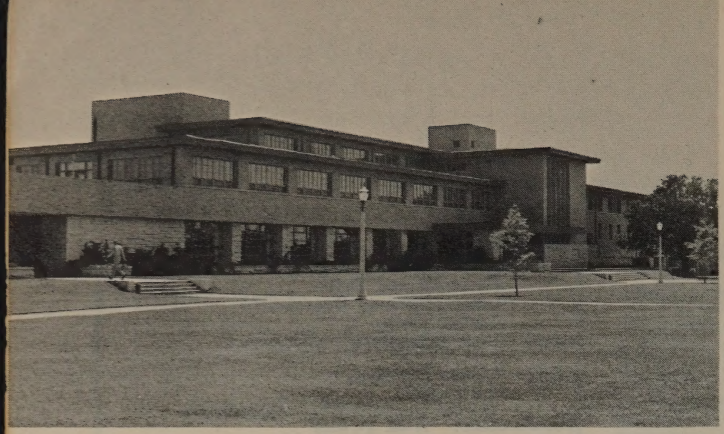
11:00 Floor Discussion

11:15 Forming a Farm-to-Market Road Program
G. A. Youngs, District Engineer
Texas Highway Department
Atlanta, Texas

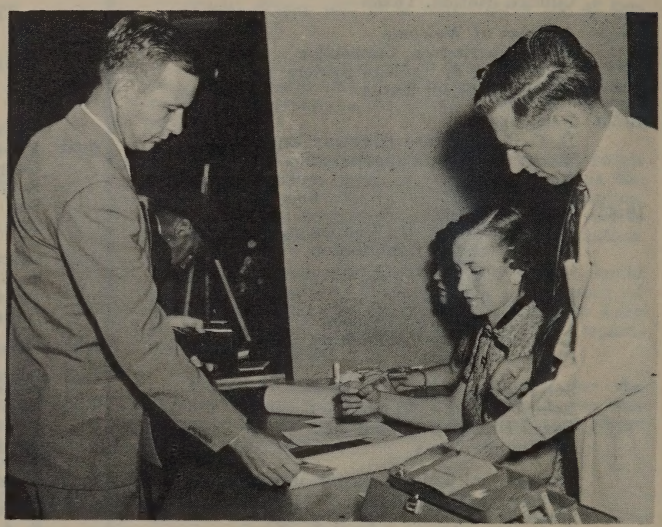
11:35 Discussion
T. O. Foster, Jr., District Engineer
Texas Highway Department
Corpus Christi, Texas

11:45 Floor Discussion

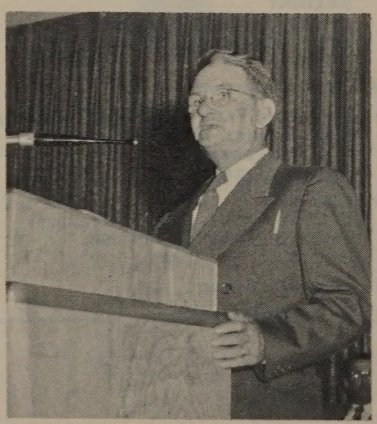
12:00 Adjournment



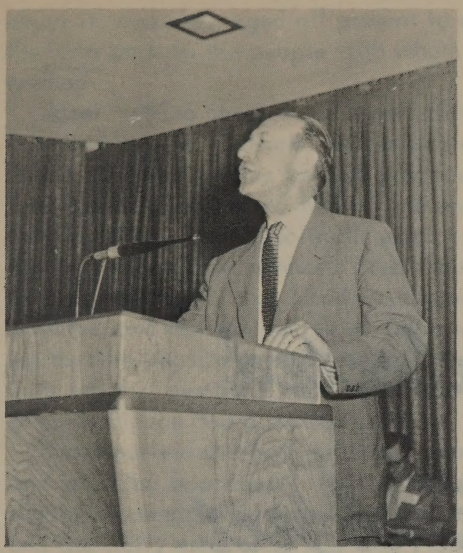
Memorial Student Center, site of Short Course meetings.



Registration, Memorial Student Center.

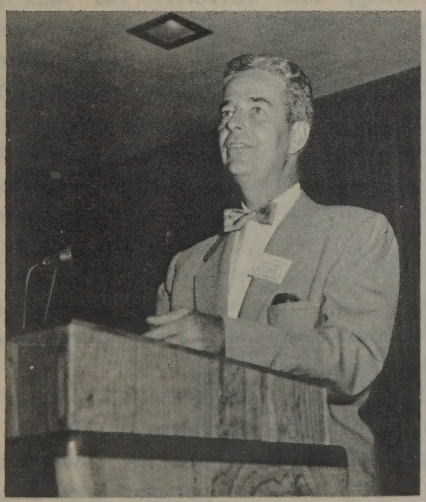


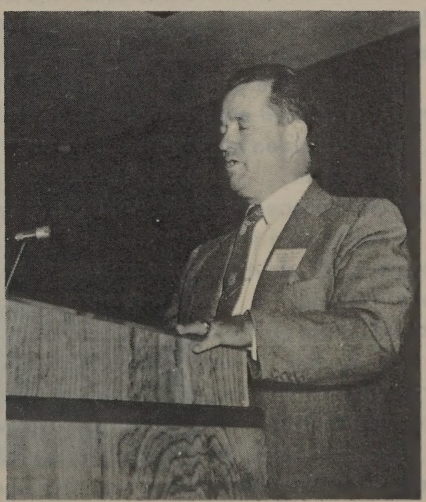
Chairman for the September 30 morning meeting was S.R. Wright, head of the Civil Engineering Department at A&M.



M.T. Harrington, Chancellor of the Texas A&M College System, gives the Address of Welcome.

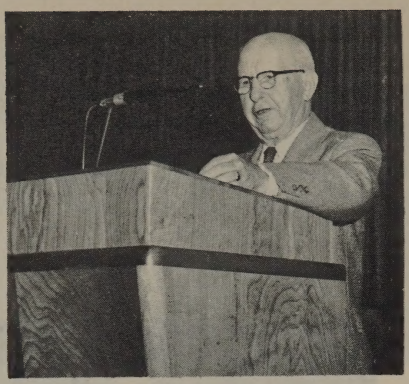
Response is given by D.C. Greer, State Highway Engineer.





E.H. Thornton Jr., Chairman of the Texas Highway Commission, and Marshall Formby, Commission Member, speak on selected subjects.*

*We regret that papers were unavailable on the speeches made by E.H. Thornton Jr. and Marshall Formby.



Selected Subject

Robt. J. Potts, Member
Texas Highway Commission
Harlingen, Texas

It is four years, six months, and twenty days since I first appeared on this Short Course program, exactly 24 hours after I had taken the oath of office as a State Highway Commissioner. Naturally, I was unprepared, but I stumbled through some brief remarks regarding the need for more liberal financing for the Highway Department. Particularly, I stressed my belief that those then before me constituted the best available group of missionaries to carry those needs to the attention of the very large cross section of the people of the state with whom they worked every day. In this brief talk, I have decided to go back and plow that same field again.

But before proceeding along that principal line, I would like to digress long enough to bring you a bit of information which may be of some interest.

You will note on the front of your programs that this is the "Twenty-Seventh Annual Short Course in Highway Engineering," thus indicating that the first Short Course was held in 1927. And that reminded me of a printed circular which I had recently come across in one of my old transfer files, and which I now hold in my hand. This circular was issued by the Agricultural and Mechanical College of Texas during the fall of 1913, intended for distribution to county judges and to chambers of commerce. Its title was "Short Course for Road Supervisors and County Surveyors"; January 12 to February 7, 1914. It offered one month of elementary instruction to men, over 21, then engaged in these lines of employment, and who had never had college training; no college credits were allowed and no certificates of any kind were awarded. The course touched on use of instruments, profiles, grading and drainage, surfacing, and culverts. No fees were charged, and a student's actual expense was estimated as low as $5 per week. This was actually the second or third year of those Short Courses, and the attendance was quite encouraging. Mr. R. B. Pearce, later with the Magnolia Petroleum Company in Dallas for many years, was my assistant and carried most of this work. I am unable to give you a fill-in on this work after 1914, nor do I know whether this early-day "Short Course" influenced in any way the name of our present series of meetings.

Now let's get back on the main line of this talk. At the Short Course of 1949, I had no official data from the staff. I was speaking purely from such personal knowledge as a good average citizen should have. Of course, I had no manuscript and I do not now recall a single figure I used in posing the financial difficulties of the Department. But I do know that what I "put out" sounded bad, even to me, and I did a lot of crying

about it, and also urged all present to carry the facts back to the people with whom they worked.

After talking about six or seven minutes, I called to the platform and presented a friend of all of us, my lovable predecessor, Fred Knetch, and asked him to use my remaining time. He did so in his usual pleasing and acceptable manner. Fred thought I was too pessimistic; that I had overstated our troubles, and that the people of Texas would see that the Department was promptly supplied with what it needed. I suspected that most of my audience had a similar view.

Now four and one-half years have passed, and what has happened? First as to the estimate of needs. We found that Mr. Greer and the staff, especially Highway Planning, had a great deal of data on hand, and had made at least one over-all estimate and report several years prior to 1949. The study was continued and accelerated. By the spring of 1951 the data was practically complete and by the year's end Mr. Greer presented us the document "Highway Needs and Costs - January 1952," upon which we have rested our case. If you do not have this document you should ask for one. It probably needs a lot of revising by now, but it will still serve for good approximations. Its totals make my 1949 talk sound puny indeed.

Maintenance cost is growing very rapidly. It will grow more rapidly each year. Pure maintenance was three and one-half times as much in 1952 as it was in 1942. Pure maintenance in 1952 exceeded construction expenditures of any year up to and including 1946 except four years which topped it by small margins, and those were the years in which we constructed nearly all the mileage on our principal systems.

It is no part of my plans or hopes that you shall start out to campaign for greater highway funds. That should be the work of someone else, and will be if all the people can learn and understand even half of the facts as to urgent highway needs. On the other hand, I know of no other group which has both the facts and the opportunity to convey them widely and well to equal what this group can do — not in argument or debates but just in ordinary man-to-man talks which you are constantly having everyday. This was the point of my talk in 1949 — it is also my point today.

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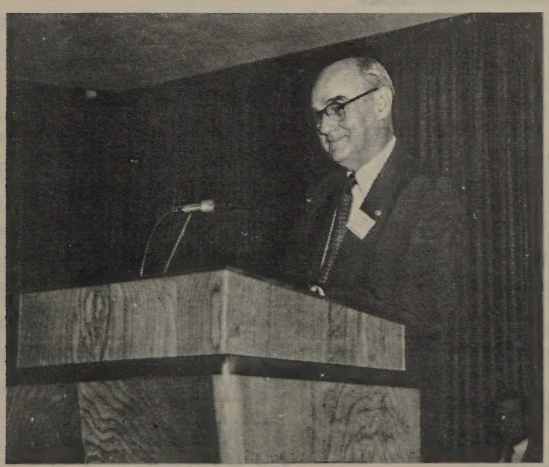
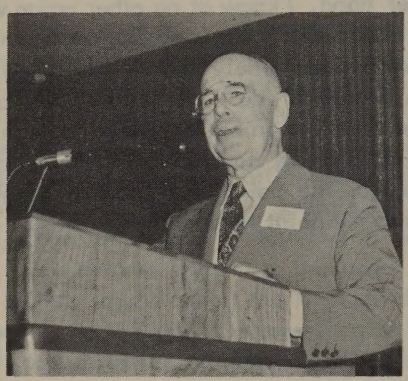


Gibb Gilchrist introduces the next speaker, Thomas H. MacDonald.

Remarks On Transportation Research



Thomas H. MacDonald
Distinguished Research Engineer
Texas A. & M. College

In the current issue of a popular magazine there is an article entitled "They Sink Fortunes in Auto Tests." This is a brief but informative account of the physical plant and the operations of the motor vehicle proving grounds which are maintained by each of the important manufacturers.

The rigorous testing, frequently to destruction, by "intelligent maltreatment" is an indispensable element in the processes each manufacturer employs to improve the quality and performance of his product.

A single proving ground does not satisfy some of the companies which have supplementary installations for testing under desert conditions and also, cold rooms for observations of the effects of artic temperatures.

The personnel continously employed for one installation may run as high as 400 and the testing equipment provided exhausts the whole range of precision, electronic, and other devices for measuring and recording test results. The investment in the plant reaches into the millions and the operations cost require the annual expenditure of more millions.

These proving grounds are provided solely for the testing of finished and semifinished products and experimental models, the latter of which may not reach the production and marketing sequences for years. But before the proving ground stage is reached, the test cars themselves were brought into being by

research and applied technology. The proving ground operations may be termed advanced stage research or research upon research.

The automotive manufacturers deserve high acclaim for the technological policies consistently followed from the early days. One of the great industries of the world has been created without serious reliance upon protective tariffs, patents, monopolies, or cartels. Achieved supremacy in the domestic, and in the world market, is largely the result of research and applied technology covering every field of design and production. The policy of constructive research is an outstanding characteristic of all major industries which have grown rapidly and which are expanding their operations. A broad study might well prove that an adequate research policy is an essential element of the economic health of any industry, but we are concerned here with the impact of automotive research upon our highway situation.

While we applaud the achievements and continuous progress of the automotive industry, as highway engineers and administrators, we must recognize that the results of research in the automotive field have brought down our highway house around our ears.

There is widespread complaint that our present highways are inadequate. The increased number of motor vehicles in operation (estimate of the Bureau of Public Roads for 1953, is 54,700,000 registrations) is so insistently apparent everywhere that the increase in numbers of vehicles is the most commonly assigned cause of highway inadequacy. This assumption, like many of the other things we know about highways, is not true or more precisely, is true only to a limited degree. There are areas in the central sections of cities, and also specific locations which periodically attract large crowds, such as stadiums where football and other contests are staged, where the increased numbers of cars do create the problems of congestion. Outside of these special areas, our highways have suffered greater obsolescence and depreciation through changes in the way we use the motor vehicle, and through changes in the services required of motor vehicles than have been caused by the increase in numbers. These changes have been made possible largely through the research which has been unceasingly applied to the design and production of the motor vehicle.

Such a statement, to be generally accepted, requires verification by the records. The large mileage improvement of main roads took place during the period 1920 - 1935 for the nation as a whole. The design standards used were closely restricted to the minimum requirements of the then prevailing manner of use and classes of use of motor vehicles.

A comparison in detail was made last year between the service demands made by the vehicles used for the base period 1920 - 1930, and the service demands of vehicles as used in 1952. On a numerical basis only the increase in numbers of vehicles by 1952 had multiplied the service demands of the base period by two and two-thirds but the changes in the manner of use and in the classes of services required and the increased numbers had multiplied the service demands upon our highways eight times that of the base period. The analysis which supports this statement is too long for inclusion here, but is the subject of an earlier paper.

These changes of use apply particularly to the rural highways. The urban problem of congestion during the base period was not yet a problem. That too is largely a product of change — this time changes in the pattern in population and population distribution. The increase of population, the rapid growth of industry, the spectacular outflow of central city population to the periphery areas have created the conditions that are now productive of impossible traffic demands upon existing streets and highways. But again, the most exaggerated traffic inadequacies of city streets is caused by the way we use the motor vehicle in urban areas.

As an example of changes in the methods of use of the motor vehicle, in the base period the average speed on rural roads was 26 miles per hour and 90 per cent of the cars traveled under 40 miles per hour. The average speed for 1952 was 50 miles per hour and 90 per cent of the vehicles traveled under 62 miles per hour. The 100 per cent step up in average speed is a potent factor causing the obsolescence of roads, but it is only one of many causes.

Had the changes in our manner of use and in the classes of services taken place precisely as they have, but without the large increase

in numbers of motor vehicles, our current highway problems would have resulted very much as we have them. A 26-mile-per-hour highway is inadequate and dangerous to a single 50-mile-per-hour car. Perhaps the pressures for remedial action would have been less with less car users, since these appear to be somewhat proportional to the number of people affected, or as we may put it, afflicted.

Very largely, these changed conditions have been brought about by research extending into the multiphase complex of motor vehicle design, production, use, and financing methods; for these have produced the modern motor car, and made possible its purchase in such fantastic numbers.

The hierarchy of interest includes, of course, the rubber industry whose achievements through research have far surpassed the expectations of the pioneers of that industry. The development of the heavy duty pneumatic tire contends strongly for prior importance with the motor vehicle itself. Without it, we would not have in such numbers the long distance, fast-moving busses, the intercity trucking, or much of our most efficient road equipment.

But the influence of research cannot be limited to the motor vehicle and its auxiliary elements in its relationship to increased raod demands. The expanding demands for transportation keeps pace with the rapidly growing fabric of industrial and agricultural production, which is, itself, largely a product of research and applied technology.

Since the degree of inadequacy of present road plant degree is largely caused by changes in the performance of the motor vehicle made possible only through research, it is logical that we turn to research to provide the ways and means to combat the many highway problems that have been generated.

Without turning aside from the main theme, it should be noted that through the failure to accept the vital relationship of the highway plant to the defense transportation requirements of the war years and the reconstruction period following, we lost a major part of ten years of normal highway rehabilitation through no fault of the highway officials. The current inventory of marginal and submarginal roads has been increased by the accelerated depreciation that might have been avoided by more intelligent national policy during the war years.

It is inevitable that the rapid growth of the use and penetration of the motor vehicle into all phases of our social and economic pattern, together with the accelerated depreciation and curtailed restoration of highways during the war period, has created conditions that will require a long time to meet adequately. The period stretches into a questionable future unless research in every phase directly and indirectly related to highway transportation is activated on a scale never before undertaken. Emphasis is needed more particularly in the economic, legal, and financing phases. It is encouraging that research has been gaining ground slowly but surely, as evidenced by the number of research workers who come together for the annual meeting of the Highway Research Board. Last year, about one thousand were in attendance. They came from the highway departments of the states, counties, and municipalities, from educational institutions and from industries. For the most part, these men are specialists. Their work is indispensable. Their number needs to be greatly increased, and their professional status should be recognized as on a level with the ranking positions in highway organizations. A plan that will augment rapidly the number engaged in highway research is seriously needed in every state.

There is a second consideration, that of finance. While a substantial total is now being expended for research when all projects are brought together, there is a need to provide for some large projects whose financing has proven to be much more difficult, although the very difficulties have introduced some compensating features. What may be termed the "community of interest" plan for research has made possible two of the largest of the highway research projects that have been undertaken in recent years.

For the Maryland Road Test I, twelve states, the Bureau of Public Roads, and a number of automotive, tire, and oil companies banded together under the leadership of the Highway Research Board to supply funds, personnel, and equipment. Also, for the Malud Idaho Test, which is now underway, the eleven Public Land States and Texas, the Bureau of Public Roads, and a group of automotive, tire, and oil companies are

cooperating under direction of the Highway Research Board.

The delays and difficulties attendant upon the actual initiation of these projects are indicative of the serious inbalance between research to provide for improved highway facilities and research to provide improved motor vehicles. The contrast is sharply defined. The cost of either one of these principal research projects would keep the proving grounds of just one major automotive company operating for less than one month. Yet, these are the largest of such projects undertaken since the Bates Road Test in Illinois in 1922 - 1923, 30 years ago.

A much larger test road project is under consideration by the American Association of State Highway Officials. Results that would conceivably come from the projected test, with the background of the Maryland and Malud tests, would profoundly affect the design and construction of new highways that at present cost levels seem certain to reach four to five billion dollars annually. There would also be the influence upon legislation, particularly with relation to highway use and highway safety.

The cost of this proposed project, the realizable value of which would be very great, would be less than the annual expenditure for the operation of one of the larger proving grounds of a single automotive company. It will be a very great loss indeed if this project is not carried through, since it would clarify many technical and public problems that are basic to the formulation of sound public policies to regulate highway use, and to eliminate much uncertainty from very large highway expenditures.

It would be difficult to overemphasize the compelling influence exerted by research upon the growth of industrial production. Essentially the same is true of agricultural production. The evidence is all about us that the highway engineer and the highway administrator of state and local governments are matching their wits against highly dynamic forces. Force is defined as, "that which changes velocity," and for both industry and agriculture in Texas the velocity change is all on the plus side. So the force that is created by research and its results (which are made possible by great natural resources and a spirit "to do") will demand transportation larger in quantity, and better in quality. That can only be realized through research.

Since the highway administrator can only expend funds for the purposes approved by legislative enactment, it would be only wishful thinking to rely upon large funds for a detached research program. But a very extensive research program is the only possible direction finder for the ways and means to meet the increased demands of industry and agriculture and to relieve urban congestion. The problem then is reduced, and it is a fortunate circumstance rather than the reverse, to reliance upon a "built in" plan of research which means enlarging the scope through the resources available.

This enlargement is possible by application of the principle of "community of interest," and a highly promising pattern of operation is even now rapidly maturing. If this concept of "community of interest" to carry forward an adequate research program of highway improvement merits the faith and adherence of the group represented here, it will be a more secure foundation than large appropriations for the purpose. The plan for the most part makes use of what we have, to effect useful purposes.

For example, here are two major state agencies, the State Highway Department and the A and M College System. The Texas Legislature has approved their joining in research. The State Highway Commission; Mr. E. H. Thornton Jr., Mr. Marshall Formby and Mr. Robt. J. Potts, after careful consideration, authorized Mr. Greer, State Highway Engineer to make an agreement with the College to carry on a cooperative program of research.

The Board of Trustees of the A and M College System likewise authorized the Chancellor, Mr. Gibb Gilchrist, to enter an agreement for the same purpose with the Highway Department.

Acting under these authorizations, Mr. Greer and Mr. Gilchrist executed a formal agreement for a cooperative research program effective December 31, 1952.

While these are the necessary legal and administrative steps which formally initiated the present research program, the cooperation between these two important state agencies has been continuous more than 27 years as

evidenced by the age of this Short Course. This annual meeting is typical of continuing contacts of a helpful nature so the new research program is not a departure from, but an extension of, existing relations and the creation of opportunities for broad studies of mutual interest.

The Highway Department and the College have in their field and headquarters staffs highly qualified engineers, economists and specialists in many technical lines. Each has laboratories under competent direction. The Highway Department annually carries on very large operations of highway maintenance and construction with many auxiliary activities. In these resources lie part of the answer to the challenge of the large expenditures by industry for research. Together the two agencies have men and resources regularly occupied upon activities which in many respects are closely akin to research problems and which also include the function, also essential, of training personnel. With good will and the recognition that the public's interests are paramount, the objective of competent and adequate research can be realized through application of the "community of interest" principle.

There are others who are logical adherents to such a program. The contractors of Texas are outstanding in the high quality of their organizations and in their attitude toward the public's interests. They can be relied upon for the introduction of promising modifications of construction details or of proposals that would lower costs or increase quality.

The commercial users of the highways have a big interest in better and safer roadways. Some excellent criticisms and recommendations were obtained by design engineers of the Bureau of Public Roads by riding on long trips with truck drivers.

Perhaps this concept of "community of interest" may appear more optimistic than real as a solid foundation for expansion of the research program to the required dimensions. If so, consider the definition of research - "usually critical and exhaustive examination or experimentation having for its aim the revisions of accepted conclusions in the light of newly discovered facts." If there is some scepticism as to the "community of interest" adequacy to motivate research, consider the implications of these questions.

Who is more interested or in a better position than the field engineers of the Highway Department who live with the roads day and night to recognize, by experienced observation, problems of materials, design, construction or utilization?

Who becomes more keenly aware of details or road alignment or combinations of grade and alignment that make the driving of a heavy truck hazardous, than the truck driver?

Who is in a position to know the missing technical information in road or bridge design better than the highway design or bridge engineers who must plan a technically sound project or the instructor who teaches the subject?

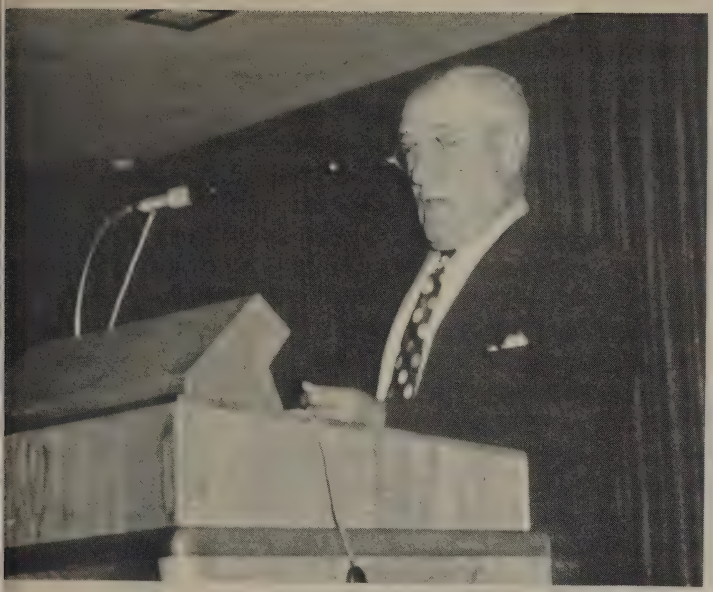
Much of the lost motion and frustration in research is caused by a failure first, to find and second, to analyze accurately the key problem or problems. Not until any problem is analyzed and thus defined, is there a chance to take the sequential steps necessary to its solution.

Very recently State Highway Engineer Greer appointed a Research Committee for the Highway Department composed of the heads of the divisions most directly concerned with research. The appointment of this committee is most timely, and will have the effect of stimulating a program of priority research projects and providing the needed contacts with cooperators both within and without the Department.

The "community of interest" plan of inaugurating and carrying forward a comprehensive program of research in the broad economic and engineering phases of highway transportation appears to fit Texas spirit and Texas temperament. It is certainly responsive to the public's interest.

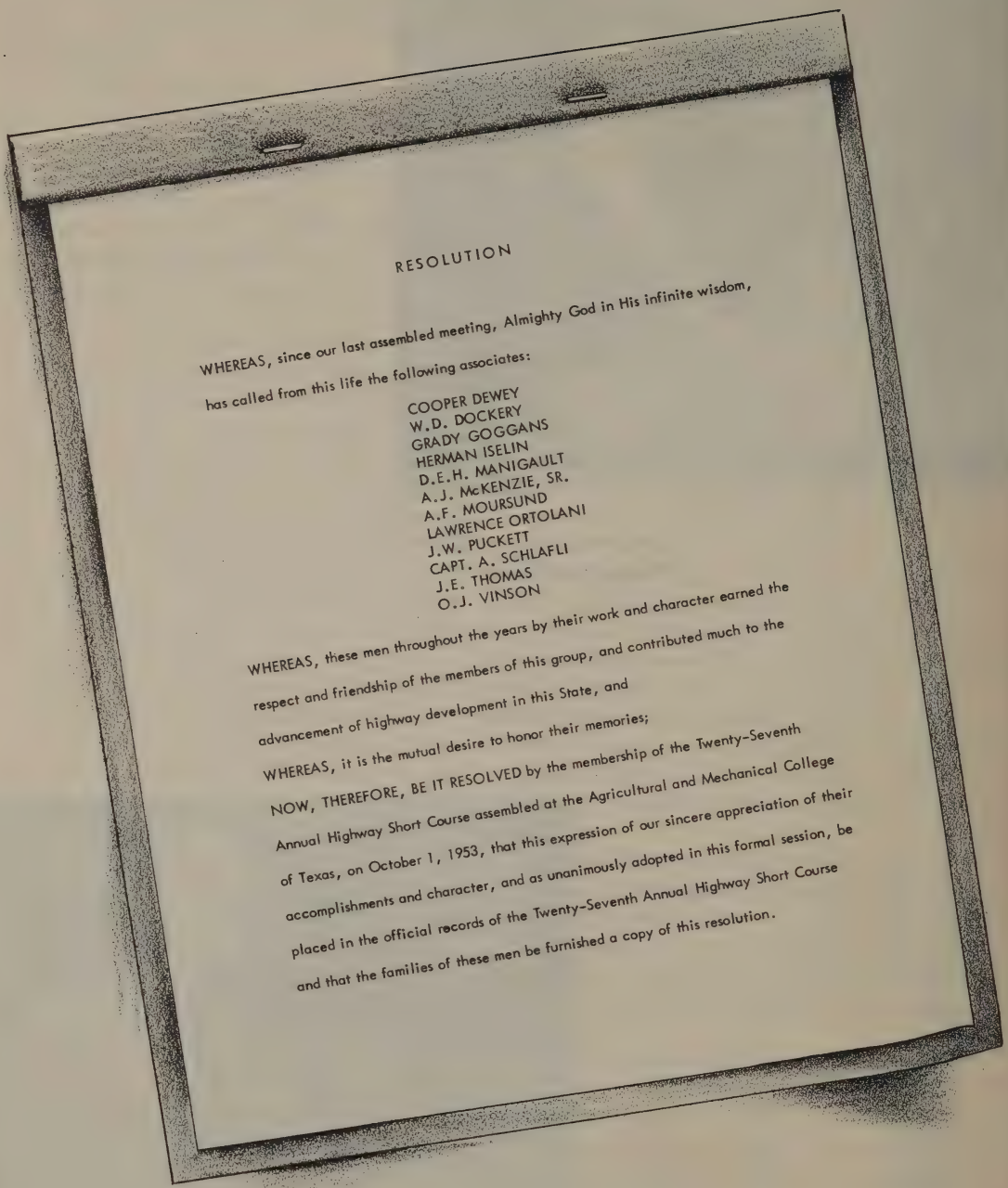
A project now in process of maturing will study customer requirements in transportation. Such a study can only be successful through wholehearted cooperation of Texas industry and Texas associations representing industry. The initial response from both of these is most encouraging.

The "community of interest" concept to activate organization of transportation research with the chief objective to serve the interests of the whole public, while of "grass root" simplicity, has the Texas qualities of directness and a touch of idealism.



Chairman for the afternoon session on September 30 was Leo Ehlinger.

Randle B. Alexander reads the resolutions passed by men attending the Short Course.



RESOLUTION

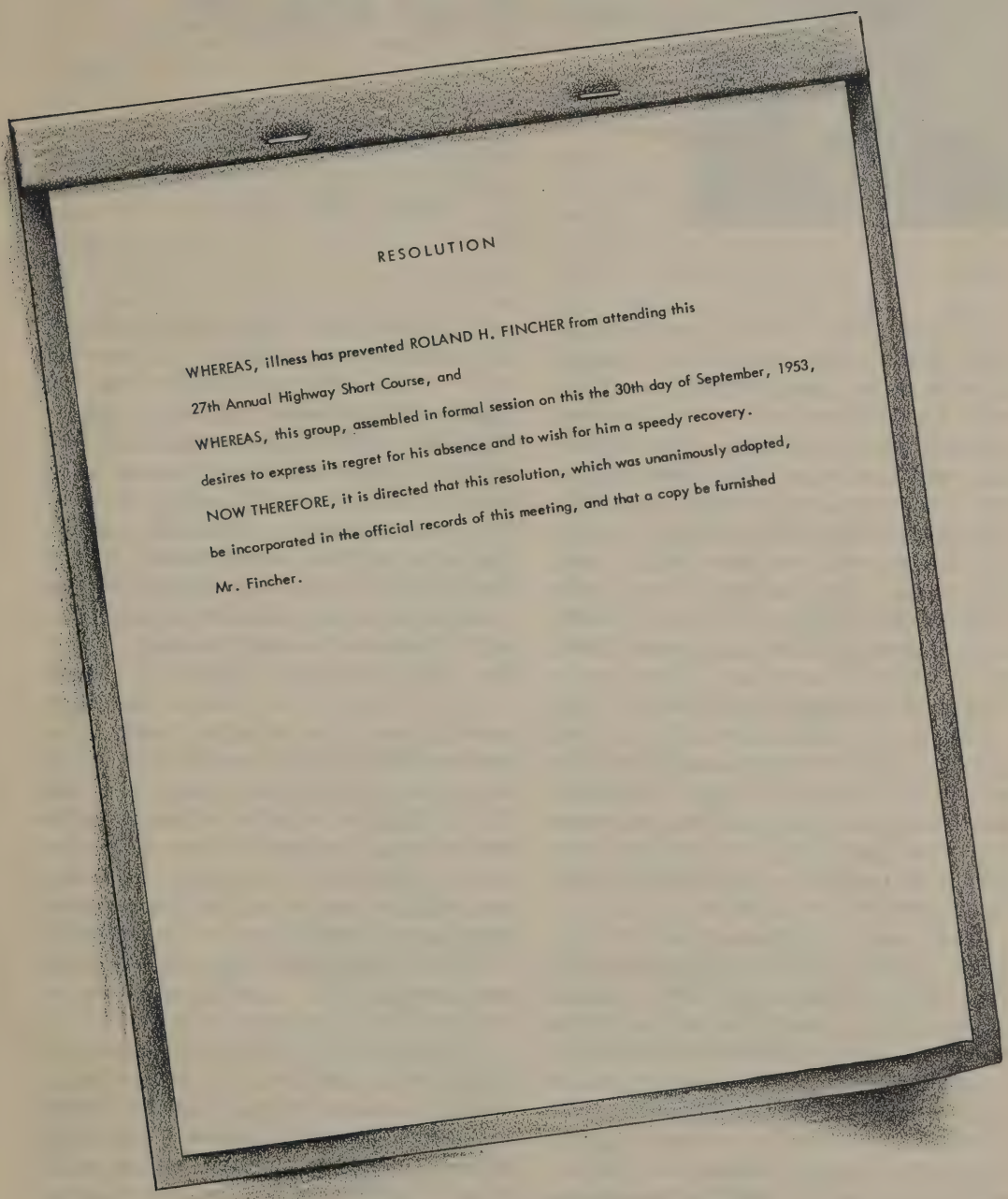
WHEREAS, since our last assembled meeting, Almighty God in His infinite wisdom, has called from this life the following associates:

COOPER DEWEY
W.D. DOCKERY
GRADY GOGGANS
HERMAN ISELIN
D.E.H. MANIGAULT
A.J. McKENZIE, SR.
A.F. MOURSUND
LAWRENCE ORTOLANI
J.W. PUCKETT
CAPT. A. SCHLAFLI
J.E. THOMAS
O.J. VINSON

WHEREAS, these men throughout the years by their work and character earned the respect and friendship of the members of this group, and contributed much to the advancement of highway development in this State, and

WHEREAS, it is the mutual desire to honor their memories;

NOW, THEREFORE, BE IT RESOLVED by the membership of the Twenty-Seventh Annual Highway Short Course assembled at the Agricultural and Mechanical College of Texas, on October 1, 1953, that this expression of our sincere appreciation of their accomplishments and character, and as unanimously adopted in this formal session, be placed in the official records of the Twenty-Seventh Annual Highway Short Course and that the families of these men be furnished a copy of this resolution.

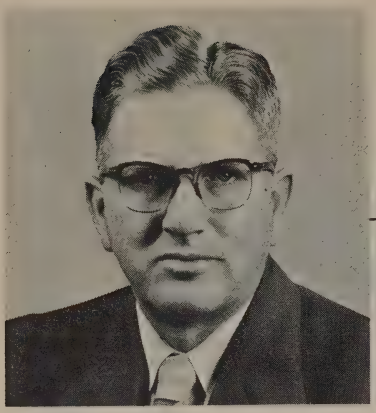


RESOLUTION

WHEREAS, illness has prevented ROLAND H. FINCHER from attending this 27th Annual Highway Short Course, and

WHEREAS, this group, assembled in formal session on this the 30th day of September, 1953, desires to express its regret for his absence and to wish for him a speedy recovery.

NOW THEREFORE, it is directed that this resolution, which was unanimously adopted, be incorporated in the official records of this meeting, and that a copy be furnished Mr. Fincher.



RIGHT-OF-WAY PROBLEMS

L. B. Dean, District Engineer
Texas Highway Department
Wichita Falls, Texas

A study of the history of our Nation since the landing of the Pilgrim Fathers more than 300 years ago reveals a great deal in the development of our highway system. The landing was made, so far as civilized nations are concerned, on virgin territory that was inhabited by a people a little behind what was then considered modern times. The natives knew their way around and did not consider there was any great difficulty in moving from one location to another. They had a system of marking their trails so that a stranger could follow the desired route. I doubt very seriously that they had to go into the courts to secure right of way for these trails, but there were most certainly many other hazards and problems encountered and solved one way or another.

The mere mention of the phrase "right of way" immediately starts a train of thought that gets lost in a fog. As population becomes more dense and land values increase, the fog thickens. We search harder and harder for beacons to guide us. Certainly we do not want to eliminate the fog by going back to those early trails, so, we just set our course to meet the problems head on. And, as civilization spread across the continent, the need for roads went along not far behind, and with this need for roads, it is safe to assume that all the accompanying problems were on the heels of the engineer.

Right of way is of no great concern to the average citizen. He takes it more or less for granted that the related problems are headaches for the Highway Department officials and county officials on which to reach some agreement. Or, most likely, he does not realize that any difficulty exists. Perhaps we are contributors to this lack of interest in not discussing the various situations more freely with our friends and acquaintances. About the only discussion we have is some caustic remark that Old So and So is causing us a lot of grief because he won't sign the deed and it looks as if he will have to be condemned. We feel the details of a little time spent in transposing technical terms into lay terms is not worth the effort. Actually, you will be surprised at the interest developed in this type of discussion with that friend who cannot understand engineering talk. Let's come out of our shell and do more of it.

The engineer is becoming more intimate with the phrase "right of way" and he is acutely aware of the hidden meanings conveyed when it is mentioned in his presence. It already gives him ulcers to even think about some major improvement, and as time goes on he will become more deeply involved with the local officials, civic clubs, and citizens in the development and design of the project. But in the end some solution usually is reached. In the meantime, it is a safe

bet that the engineer is not alone with his ulcers.

Let us go back briefly to those early days and examine the development of our present highway system. As stated earlier, our present system began with trails, usually foot paths. The width of the trail was not important, just so there was sufficient space to accommodate the natives, usually in single file. But with the coming of the early settlers, carts and carriages imported made additional space necessary. Even this change did not create any unusual problems, our country was open and not fenced. The only requirement was some extra meandering with some dirt moving to maintain passable grades.

However, we know that not many years passed before certain property lines were established and through necessity the roads began to follow property lines. Real estate was cheap, and the general rule was to donate any that was needed for roads. We cannot hold our forefathers at fault because they only used what was needed at the time. We have been doing the same thing for years.

However, there were some who led the thinking that additional widths were necessary to provide safety, convenience, and the future widening for an increasing traveling public. But these few were ahead of their time. The full truth did not dawn on us until mass production of the automobile began. Even then we were satisfied with seventy or eighty feet. I say again, can we blame our forefathers. It has not been many years since we stepped up to one hundred feet, and we thought that was good for all time to come. We can see now that those ideas were false, and we should not be too hard on ourselves for not being able to visualize even our present-day needs. There may be some, but very few indeed, who could forsee our present-day conditions. The alibis we give future generations will not sound any better to them than the reasons we find in the past do to us.

Automobile production and vast increases in traffic movement all over our country showed us, almost before we realized, that our facilities were not sufficient for the tremendous load being carried. The birth of multi-lane highways was upon us so suddenly that we began groping in the dark for a highway section that would fill not only our present needs, but those in the future. Already, we see that our earlier efforts to solve this situation were inadequate. Rights of way purchased on the latest design ten years or less ago are substandard now. I am thinking that some of us will be making excuses to posterity for being short sighted and not providing sufficient right of way long before we leave this life.

If it is at all possible to use our present facilities and forecast what the future requirements may be, by all means this should be done so that our sons will not be forced to follow us and move fences back for additional space on the same miles that we have moved them back already. This puts us on the spot whether we admit it or not. It is no easy matter to convince the local governments that it is absolutely necessary to require the additional space, especially if in the meantime the adjacent areas have been built up with business establishments or residential districts. So, what have we done more recently? We have designed a section that in our humble opinion should serve for many years to come. The multi-lane divided highways, with provisions to add additional lanes when needed and the construction of the service, or frontage road, will, we think, be ample for the foreseeable future.

Now, we might ask how this constant need for additional right of way is affecting our commissioner's courts. The use of the term "commissioner's courts" is for convenience only in this paper. The same question can and does just as easily apply to the city governments, the only difference being that the cities involved are dealing

with much more expensive property. Therefore, the problems of the city are as great or greater than they are for the county.

There are an infinite number of answers to this question of effect. It all depends on who is being questioned. But, the underlying principle behind almost any answer you may receive has to do with the economic life of those involved in some way. Real estate values have advanced to the extent that the first thought in a commissioner's mind when he is asked to secure additional right of way is, "that is a good plan and is needed, but, how much will it cost us to buy the right of way." This is no idle thought. He is really concerned about it, because he is already operating on a tight budget and he knows that the particular project is in an area where real estate is at a premium. In addition to real estate being already high, certain property owners see an opportunity in some cases to advance the price of the land involved.

We will not attempt to analyze the many reasons the value suddenly rockets up on this property. But we know for a fact that the owner sees a chance to possibly get a new house, pay off a mortgage, or just get some extra cash. Then there is the type who needs none of these things. He has been very fortunate in his business dealings and has accumulated a home and possibly good property and has no civic responsibility at all. This type has lived primarily for his own interest with very little regard for his fellow man and just does not want to be bothered. He does not care to be disturbed. Just do the best you can on the present right of way.

There is always the person who is actually damaged by the need for additional right of way. It will be necessary to move his house or some other major improvement, or possibly he owns a small tract and will be crowded when the additional area is secured. Our commissioners are generally fair men and recognize a bad situation and are willing to do the reasonable thing about such cases.

The commissioner is faced with a great misconception prevailing about frontage values. We personally know of several property owners with medium to large holdings in the rural areas adjacent to a certain highway and on the approaches to the city, who have the wrong idea of frontage values. It is their claim that the land fronting on the highway is worth $1,000 or more per acre. This is probably true in at least a few instances, but they are overlooking the fact that if the right of way is widened the new front acre is as valuable as the old front acre. The only logical conclusion is this, the acre to be secured for additional right of way is no more valuable than the back acre of the tract, and should not be considered so. Why? Simply because he still has the same frontage he had before the highway was widened. He still has the same access to a public road as before, and as is frequently the case, the front acre may be more valuable because of the construction of additional facilities such as frontage roads.

The difficulties mentioned are real to the commissioner. He still is searching for the answer and to him the solution is almost hopeless. This is as true on our Farm to Market System as on the Primary System. The 1954 State Farm to Market Program was being formulated a few weeks ago and in a meeting with one of our commissioner's courts, a certain commissioner said, "Don't give me any farm roads this time, I don't want to buy any more right of way for a while." This man was not belligerent, in fact he is most cooperative, he merely felt whipped on trying to obtain right of way. Yes, he received a short section of new designation and agreed to secure the right of way.

The lack of available funds for right of way purposes is creating no small problem in the counties of Texas. So long as the county continues to grow in population and wealth, right of way

acquisition will become an ever increasing problem. It is a problem that will demand time and energy from our most progressive and straight forward thinking leaders. Several of the counties are voting bonds for this purpose, which may be a temporary solution, but in all probability is not the final one. Taxes are high and interested groups of citizens are beginning to look with disfavor on any increase in property taxes. It is quite possible that the time is near at hand when any bond issue will have difficulty in passing, that is any bond issue to be paid out of an increase in taxes.

One may ask, "How does this affect the Highway Department? We too, have difficulties with finances; we will worry about our troubles and let the counties worry about their own." That is true, we do have our own troubles, but we are also vitally interested in the troubles of the counties and cities. For when the local governmental organizations can no longer purchase the right of way, then we will be forced to revise our thinking on design requirements or open up a completely new set of policies in regard to right of way. We, in the Highway Department, are not qualified to cast the first stone for in instances, we have created some of the difficult situations we find ourselves in.

I dare say there are very few of us who have not at some time on rare occasions recommended that a project be let to contract before all the necessary right of way was secured. This is poor management and has frequently, in such cases, got us into an embarrassing situation, as well as complaints and claims from the contractor for delays on the job after he has moved in and started construction. Naturally, the only reason for this type of action is that the particular project is urgently needed and we have been assured that the right of way acquisition is merely a matter of small consequence. There will be no trouble at all in securing it. We are only kidding ourselves when we make ourselves believe this, for we have all found out long ago there is potential trouble on any tract or parcel of land until the deed or easement is signed. This particular phase of our troubles can very easily be eliminated by holding the letting off until all right of way is secured.

The policies of the Texas Highway Department regarding right of way are long standing and need no further discussion. It may be interesting to note that at least one state supreme court has held that in securing right of way, either by deed or easement, we acutally only have an easement for road construction and maintenance purposes. This is thrown in as something for us to think about.

For the sake of argument, let us assume that it is possible to solve the acquisition problem. What then? There are instances where a few years ago right of way widths were determined for multi-lane highways and in some cases even secured and fenced by the counties. Now, even before any improvement has been made to the old road we have been forced by increasing traffic problems, safety, etc., to change our proposed design to allow for a divided highway and the possiblity of adding future traffic lanes. This is not only embarrassing, but has a tendency to promote the idea in the minds of the local government organizations that we do not know what is needed. We can easily see that our first ideas were insufficient and are just as confident that our present ideas will provide sufficient right of way for many, many years to come. But, do we know this, have we extended our forecasts for enough in the future? Certainly, we can see no reason why our most recent studies are not ample. The practice of securing wide rights of way in advance of actual use should be given serious consideration so that we will hold the confidence of those we deal with daily. To say that we need 100, 120, 150, or greater widths is not sufficient, since, as has been frequently the case, the stated requirement is

only in the judgement of an individual engineer. We should investigate and determine what facility can be built on the proposed right of way, or, the width necessary to provide the facilities required in the future. After the desired width has been determined, we are in a position to justify the proposal by design or maintenance requirements. The local agency should not be required to purchase any right of way that connot be justified.

There are several possible methods of eliminating a great deal of the problems in securing right of way, and we will have reached a milestone if we live to see some of them in effect. The practices of securing right of way are generally obsolete in Texas. There is an infinite number of methods in use, some good, some bad. We do not have any basis upon which to judge the value of real estate from a scientific, mathematical, or any other method. It appears something along this line may be desirable.

We are constantly aware of the fact that future right of way will be more difficult to secure when we see a building of some sort being erected adjacent to the present right of way lines of a highway that we have every reason to believe will eventually be widened, and there is nothing we can do about it.

But, it is my firm belief that something can be done. There is at least one instance in which the method about to be offered is in effect, not on a highway, but near an air field. This is a County Zoning Ordinance to control buildings and other improvements. The zoning ordinance is being used to control building near the airport, and by the same token proper legislation is possible for use in controlling all rural building, especially in the vicinity of our major highways.

The final effect of the increasing acquisition difficulties will have a very definite bearing on the future of our highway development. The time may not be too far in the future before we begin to feel its effects. Certainly we should bend every effort in assisting to solve this vexing problem, because we do have an interest in its solution.

This paper has dealt with a few of the many problems being faced by the counties, cities, and our own Highway Department. We realize there are many more that have not been mentioned, or thought of. Doubtless, every person present is thinking of many others more important than those mentioned, and in all probability has better solutions for them. These problems are real and we are in daily contact with some of them. Also, we recognize the many adverse effects that are possible to our entire future highway programs because of them.

We do not have the final solution, but if even a little constructive thinking has been generated among ourselves, that in itself has been worth while. We do know that our present thinking has been revolutionized to the extent that our present design standards will accommodate many times the traffic that our old two-lane highways were designed to carry, and many times the traffic using those highways at present. We have started in the right direction, and about all we need to do now is come to a full realization of the growing problems and plan for future growth in traffic demands. When this has been accomplished, then our sons will look upon this generation as a generation with vision.

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District Safety Council

R. E. Lindsey, Director, Insurance Division
Texas Highway Department
Austin, Texas

Most of you will recall reading a recent news report that 30,000 of our men lost their lives during the three years fighting in Korea. There were many thousands more maimed, certainly. Shooting wars of a necessity have their casualties. All people do not agree that wars are necessary, but fighting always produces terrible casualties. But how about the accident toll in this country in peace and in war? Is this unbelieveable loss of life and limb necessary?

I wonder how many of you know the approximate number of fatalities caused from accidents that occurred in this country during the same time that the 30,000 Americans were killed in Korea? According to the National Safety Council the number was over 143,000, or about 48,000 a year; almost five times as many people killed by accidents in this country as were killed in battle during the same time. It is hardly necessary to mention that during this same three-year period there were nearly 14,000,000 injuries, costing many millions of dollars in medical aid and time lost, and other costs. Of course these accidents caused much pain and suffering also.

Now let us get nearer home. What about our own accident loss record? Looking at that record, it is found that from June 1, 1950, through June, 1953, the period during which the war was raging in Korea, we suffered 23 fatal injuries to Texas Highway Department employees. Over half of these were traffic injuries occurring while the men were working on or near the traveled surface. During the same three years we had almost 1,000 lost-time accidents entailing a charge of over 220,000 man-days lost. (This is in accordance with The National Safety Council schedule, which charges 6,000 days for fatality.) At eight hours per day this would amount to over 1,780,000 man-hours lost.

As you probably know, this 1,780,000 man-hours is slightly less than the total man-hours of the largest district for the last fiscal year, and about three or four times the number of man-hours of some of the smaller districts for the same fiscal year. So this accident loss, both in suffering and in dollars and cents, is close to all of us in the Texas Highway Department, as well as in the homes and elsewhere.

What can be done to reduce the needless loss of life and limb, and of dollars in this Department? Who is in the best position to reduce accidents?

It is our thought that the man who does the work and his immediate supervisor can best be depended upon to control work accidents, if they have

the necessary encouragement and assistance from the management of the district. This worker and supervisor can best make safety an integral part of the job, and not something added, if they have the necessary assistance.

If we look at this accident loss situation in one light, it might appear to us that all that is necessary to get the job done efficiently is to employ the best personnel possible and to give them initial instructions as to how the work should be done. Since we desire to have them work safely we take them aside the first day and explain the safe way to proceed, then sit back and know that everything will go along smoothly without any letup in efficiency or in safety consciousness. Certainly all of us realize that this is not the case, that there must be a follow-through in both cases, human nature being what it is.

We think that probably the follow-through can best be done by top management. We believe that in any organization such as a district, much can be done toward reducing accidents, and thereby stepping up efficiency through a business-like committee or council set up within the district. Several districts have set up a committee to investigate and report on equipment accidents. Possibly this committee could be enlarged and some other important duties added. It has been suggested that a sufficient number of the following should make up this council or committee: District Engineer, Assistant District Engineer, Construction Engineer, Maintenance Engineer or Superintendent, General Foreman, Chief District Accountant, Equipment Supervisor, and possibly others of the supervisory personnel of the headquarters staff. Also, one Resident Engineer and one Maintenance Foreman, the latter two to be rotated about every three months in order that the whole district will be familiar with the setup and working routine of the council. This procedure should cause each supervisor to realize that he has a part in the district-wide activities. We would like for the Safety Instructor to attend these meetings whenever possible and assist in any way that is indicated.

There are many worth-while matters in the district setup that this council might take care of. These duties would vary in different districts, naturally. Being interested from the accident prevention angle, we believe this group can be most effective if used to correlate and maintain all policies pertaining to accident prevention, such as safety or efficiency meetings, job inspections, first aid training, and selection and training of new personnel. It could also serve as a clearing house for all matters affecting employee relations, such as group insurance, retirement, and district social activities.

All accident reports should be studied by this committee and investigations made of as many as possible to find the real cause and to devise means of preventing similar accidents.

All safety or efficiency suggestions should be evaluated and necessary distribution made of those meriting it, being sure to give credit where due. This can best be done by a council or committee organized as indicated.

One of the most important duties of such a committee could be the supervision of safety or job planning meetings. We think these meetings do much to prevent accidents and improve job efficiency when they have the backing of the district management, are properly planned, and are conducted in a business-like manner.

There are a number of types of safety or job planning meetings that can be most effective when organized and planned carefully. Some of these are:

Lecture Type: Someone makes a talk on a particular phase of an operation. (The council can have a member do this, or better still, assist one of group.)

Demonstration Type: One or more of group actually go through different steps of a work plan, explaining same.

Safety Inspection: Tools and equipment are checked for hazards, as well as for needed repairs.

Job Analysis for Safety Study: Work plan, step by step, is studied to determine and eliminate hazards.

All of these different methods of creating safety consciousness in a group can be materially aided by a planned system of assistance from a district council or a member of that council. I think we can demonstrate this point by discussion of the last named plan of meeting, Job Analysis for Safety Study.

Generally speaking we could make a study of the hazards connected with this job from a few broad headings such as, topography, instruments and tools, and transportation; or a study of each phase of the work. Also, if we study the accident record we will be able to learn how injuries occurred on similar work in the past. So, from these sources and others, a list of discussion items or hazards can be set up. These discussion points will certainly apply directly to the work in hand if arrived at in this manner.

If the work under discussion is connected with a job that is starting the day of the meeting, or is already underway, the job analysis for safety should be more effective.

It operates in this way. The group lists on the blackboard or a sheet of paper, the different steps of the jobs that are likely to produce accidents. Then they discuss each of them briefly, pointing out the hazards and devising ways of eliminating them, listing the results of their discussion opposite the discussion points. In other words, they work out a plan to do the work immediately in hand in the most efficient manner without accidents. Now, (and this is where the district council can be effective) a copy of this job analysis is filed with the council, where a study is made of same.

Additional discussion points are added, together with any comments or corrections in regard to the right hand side of the sheet where the means of preventing accidents are shown. Thus the thinking of the men who do the work--the immediate supervisor, and the management of the district--have been combined and are working hand in hand, not only to prevent accidents but to get the job done in the most efficient manner.

There remains one most important phase for the district council. That is the follow-through. If an accident does occur on this job that has been analyzed, an investigation should be made to determine what has gone wrong, because there has been an error someplace. This investigation should get at the basic cause or causes, leaving personalities out as much as is possible, then make recommendations that will remedy this situation.

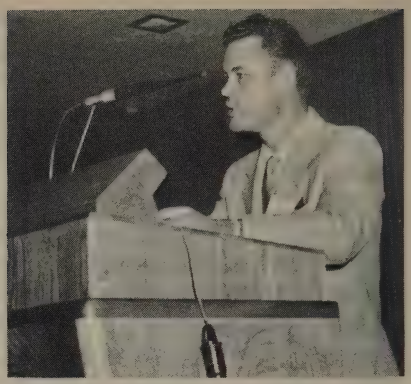
Summarizing, the Resident Engineer or Maintenance Foreman has called this group together prior to the starting of a particular job. The steps of that job have been listed on blackboard or on paper. Opposite each step known to be hazardous or to have produced accidents in the past, the remedy is placed after having been arrived at in open discussion with the aid of a member of the council, where practical.

The meeting is over but the results are filed with the council where comments, corrections, and suggestions are added and the sheet is returned to the original group for additional study. That is all except for the very important follow-through of investigations of accidents by the council.

The men on the job, their immediate supervisor, and the management of the district are working together to prevent accidents that undermine efficiency. They are working with known hazards. They are attempting to prevent these known hazards from producing accidents that are costing the department dearly in loss of life, and in painful injuries, as well as loss of money for medical and other costs. They can do much to eliminate these work accidents if the job of preventing them is approached in this manner.

THE DISTRICT LABORATORY

Frank S. Mitchell, Laboratory Engineer
Texas Highway Department
Houston, Texas



Why do we need a district laboratory, and how will it aid our districts in securing better roads at lower costs? A laboratory may be used to satisfy this purpose by enabling us to:

1. Evaluate the strength of the existing road subgrade.

2. Select the proper material for roadbed treatment, flexible base, and pavement.

3. Determine the base and roadbed treatment depth, or the pavement depth, necessary to carry the design load.

4. Explore and determine the quality of subsurface material in connection with bridge foundations in order that we may make a proper foundation design.

5. Set up materials control for use during construction.

6. Instigate and develop research programs which are of vital interest to the district.

7. The last, and most important of these functions is to help eliminate the guesswork involved in the solution of the above-mentioned problems and to substitute, therefor, factual data from which an intelligent and an economic design may be made.

There was a time in our district when two designs were used — six inches of flexible base, which was considered to be a temporary expedient, and a 9-6-9 pavement, which was regarded as a permanent facility. It is conceded that during those days this type of design may have been sufficient. However, heavier loads are carried today on our lowest type roads than ever traversed our primary roads during that era. We have the traffic and the loads, gentlemen, and from all indications neither will get lighter. Consequently, we have no alternative other than designing for them.

This then, is how a laboratory can be utilized. If we, as engineers, are familiar with the soil and material characteristics and with the loads to which our roads will be subjected, we can intelligently design for them. This is true even though we lack the necessary funds to construct our roads as we know they should be built in their initial stage.

The primary function of a district laboratory is one of service. It is a service to each engineer concerned with the design, construction, and maintenance of roads and bridges in our highway network. The services of a laboratory should be used to the fullest in such a manner that every engineer knows the characteristics of the material with which he is working. With the ever-increasing costs of engineering, materials, and equipment, it would appear that the fullest utilization of a district laboratory would be a primary step in countering both rising costs and inadequate design. It is an absolute impossibility to make an intelligent design if there is lack of familiarity with the materials being used whether it be soil, concrete, asphalt, timber, or steel.

The pattern for the organization of an efficient laboratory may be divided into five categories. These are personnel, training, equipment, coordination and scheduling, and the analysis and reporting of results. Taken in this order, personnel would lead the group as to importance because the other phases depend almost entirely upon this one. As all of you know, good personnel with fair equipment can achieve fairly good results, whereas mediocre personnel with the best equipment available can turn out no better work than the class of people using it.

It is difficult to determine which factors have the greatest bearing upon the value of a laboratory technician. Among the more obvious ones are initiative, interest, education, willingness to assume responsibility, and the ability to work with fellow employees. Generally, the quality of work of an employee is a matter of his interest in the job. I feel this interest to be a leading factor concerning productivity if his other aptitudes are equal. There is no place in a laboratory for an employee who takes no pride in his work or for one who does not enjoy it.

In laboratory procedure the only technique followed consistently is that involved in the actual tests themselves. The preparation, the test cycles, the job sequence, and the intermeshing of jobs for best results and high output depend to a certain extent upon the initiative of each employee. These operations, incidentally, are the most time consuming and it follows that they are the most costly. Consequently, initiative could also be classed as a major factor in the work of a laboratory technician.

I am afraid that in the past we have been prone to overlook the education of laboratory personnel, and worse still, the ability of the technician to educate himself by diligent application and outside study. Consideration of these factors is imperative if the quality of work turned out is to be of the greatest practical value to the engineers concerned. It seems obvious that the willingness of an employee to assume responsibility is a consequence of his having the aforementioned requisites.

There are three ways in which the second category, training, may be accomplished: by group, individual, or a combination of both. The better method of training is to use an inexperienced employee with one or more of the older employees. This method will thoroughly acquaint the beginner with a pattern of procedure that he can add to as he gains experience.

In our organization, we hold an occasional group conference at which time the various tests are discussed, along with ideas for improving our procedure. We then take a job of interest to the group and discuss each test used for the job with particular emphasis upon how the work of each technician was employed in the final analysis. These meetings are summed up with a discussion of the final analysis that is compatible with the training of the technicians. I feel that these meetings are beneficial in that they help create pride and confidence in the employee and the feeling that his work is part of a particular project, it gives him an over-all picture, and it points out the importance of accuracy in his own work. During these sessions we usually gather several ideas from our personnel. Some of the suggestions are only fair and some are exceedingly practical. If an employee has a suggestion on some particular phase and the suggestion won't work, care should be taken to point out exactly why it won't. To do otherwise tends to make the employee keep all future suggestions to himself. Suggestions which are deemed feasible are tried, and after a fair test if they prove themselves, are incorporated in our procedure. The suggestions may be many and varied but any that will save time, money, and effort, and will help maintain a high flow of output are always welcome. There is an interesting sidelight to the operation of a laboratory in that if an employee is made to feel that his efforts and ideas are appreciated, many problems with which the laboratory engineer is faced are solved for him. This is as it should be becuase this is one of the operations in our department in which an extremely high level of coordination and teamwork is a necessity.

We have found from experience that versatile employees are more beneficial than specialists. Every new employee is started on one test and as soon as we feel that he has mastered it we start him on another. When he has completed his training for the routine tests he is then able to work efficiently and can handle new tests with minimum supervision. This is necessary because our technicians work in the lab, work as samplers at industrial plants, and also work in connection with drilling operations, soil profiles, and load tests, when they are in the field. Consequently, we are able to utilize their services to the fullest and at the same time relieve the employee of monotonous repetition. It is necessary to teach a technician during the early part of his training to be familiar not only with the tests he is conducting, but to be just as familiar with the source of the material on which he is working and how it is to be used. This is impor-

tant because certain tests and procedures may be conducted upon a material if it is to be used for one purpose and an entirely different set of tests and a new procedure may be conducted upon the material when it is to be used in another manner.

As in any other work, the type, quality, and quantity of equipment has a definite bearing upon the rate and quality of output. Certainly it is uneconomical to have equipment on hand which is never used and it is just as uneconomical to lack equipment that will save both time and effort, and in turn — money. A median point must be found which can be ascertained only as the problems are encountered in each particular laboratory.

The flexibility of equipment also has a bearing upon the rate and quality of output. For example, our triaxial equipment is made up in such a manner that we conduct all triaxial operations at the proposed bridge sites. As a result, the problems of moisture loss and breakage of samples which are due to the time element and transportation involved, are eliminated.

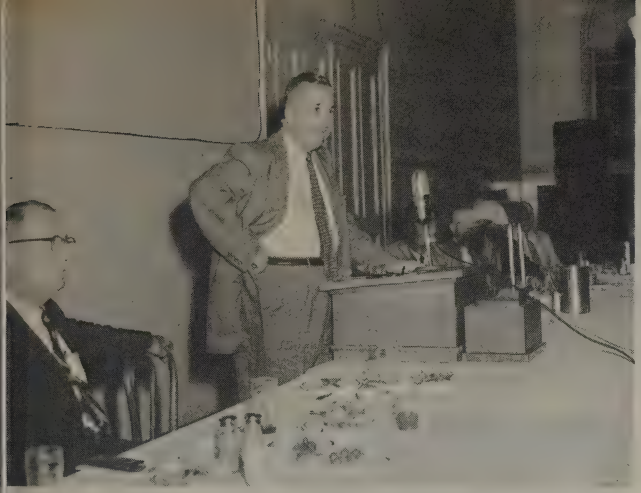
Another important phase of laboratory operation is the coordination and scheduling of work. As engineers, most of us have little regard for a bookkeeping or record system. However, in this work a good record system is not only feasible — it is imperative. It is a frequent occurrence for us to start on a foundation problem and for another job of higher priority to come in before the first one has been completed. As necessity dictates, the first job must be laid aside and the second one started. Also, by the very nature of laboratory work there is considerable lag time in the tests. A common example is the drying and wetting cycle of samples prior to triaxial tests being conducted upon them. We have no control over this cycle for it is a question of time. As a result we can't sit and wait for one cycle and a series of tests to become complete before a new job is started. Several months ago we had 28 jobs under various degrees of completion for the reasons outlined above. Some of these jobs involved over 200 tests. You can readily see the need for an accurate record system.

The operation of a laboratory involves many repetitious elements which may often be correlated by the use of curves, tables, charts, and graphs and a considerable saving in time may be effected with no loss of accuracy. Utilizing these facilities, one of our technicians can accurately plot over 200 stress strain curves per day.

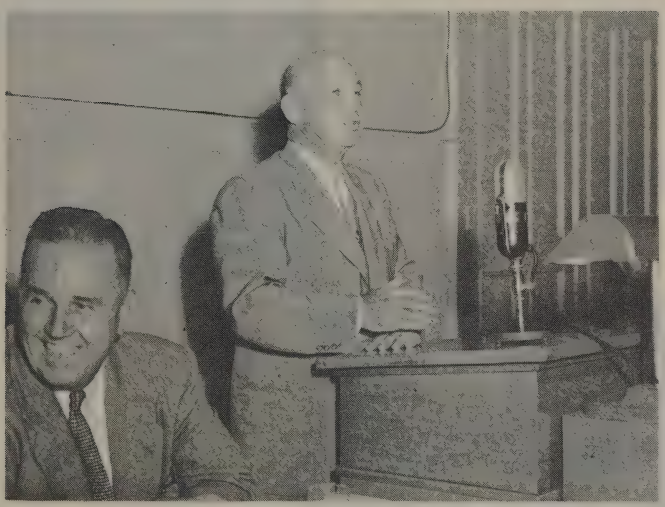
Another category pertaining to good lab technique is that of analysis and reporting of results. Regardless of the number of tests conducted, how thoroughly they were made, and how accurate the results, if they are not analyzed and reported properly, all previous work has been in vain. For the laboratory or foundation engineer to submit a folder consisting only of curves, test data, and calculations is a gross waste of time and effort for everyone concerned. He should be sufficiently familiar with all considerations involved in each job on which he works so that he may anticipate any questions that may arise concerning foundation problems. Then, these questions should be answered in the report to the best of his ability. It is further helpful if the report submitted is analyzed and interpreted in such a manner that the engineer using it will have sufficient information to enable him to form his own conclusions as to the recommendations submitted.

I have left until last the discussion of one general phase which cannot be segregated in any analysis or outline. It may be summed up in one word — cooperation. I think generally that the greatest single factor which has helped place the Texas Highway Department among the leading highway departments of our nation is primarily due to the cooperation among our members from the top to the bottom and from the bottom to the top. In order to confine this aspect within the limits of this paper, I am basically interested in the cooperation between the laboratory engineer and the various engineers who utilize the services of their laboratory.

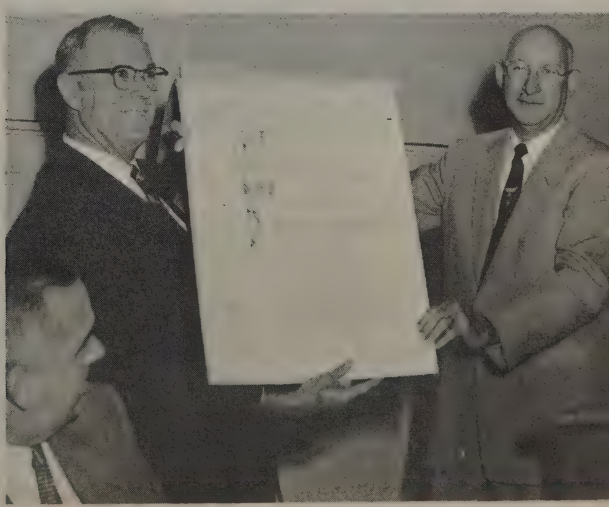
Most of our work is conceived at the district level and all of our work is constructed in the districts. It then follows that the laboratory work for these jobs should be done in the districts concerned, within bounds of engineering economy. This would enable the Austin office to properly function as consultant or coordinator by eliminating many details they now have to shoulder. As a result, we would have better coordination between design and construction and we would be one step nearer our goal — better roads for less money. This, after all, is a working definition for highway engineering.



Wick Fowler, Executive Assistant to the Governor, acts as toastmaster at the annual banquet at Sbisa Hall.



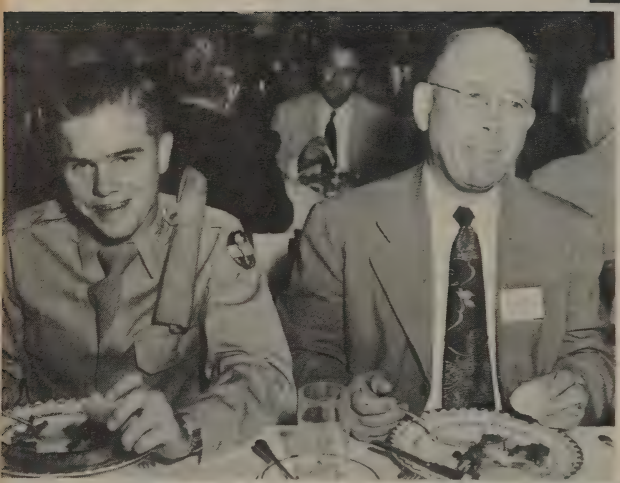
D.X. Bible, Athletic Director of the University of Texas, speaks at the banquet.



Fred Wemple, former Commissioner, receives a scroll in appreciation for his services on the Commission from F.M. Davis, District Engineer.

Random

scenes



of the

banquet.

URBAN HIGHWAY LAYOUT BY THE COORDINATE SYSTEM

George S. Meyer, Senior Resident Engineer
San Antonio Expressway Project
Texas Highway Department
San Antonio, Texas

Layout and surveying for an expressway in the City of San Antonio is unique in that the city streets were laid out originally to follow meanders of trails, the San Antonio River, and old Spanish Padre irrigation canals. As a result, the city blocks are irregular shaped with varying width streets. City monuments for block corners, or survey points for street center lines, usually set by the cities, are very rarely found. In establishing the expressway route to secure good alignment, it was necessary to cut through these irregular shaped city blocks. Only in a very few instances were locations secured that paralleled the few existing straight streets.

Because of houses, buildings, etc., being in the path of the expressway the usual highway center line could not be staked out on the job prior to actual construction. Due to the complex nature of expressway design with lanes not being parallel and separated by variable width medians, with entrance and exit ramps and frontage streets, it would be a difficult or impossible task to determine and stake a plan control line or center line during the preliminary stages. It is also true that most of the control alignment could not be designed until complete topographic information was secured and plotted. In the central business area, building and property corners must be accurately located during the preliminary stage so that the final control alignment can be located to avoid expensive properties. Exorbitant right of way costs are a factor in determining location, right-of-way widths and design.

After a complete study of these and other anticipated problems, it was decided to use a system of survey base lines for all preliminary work, and later for staking rights of way and construction control points. To simplify and correlate office and field calculation, it was decided to set up a plane rectangular coordinate system for the City of San Antonio and use coordinate calculations for all surveys, layout, designs, right of way, and construction. For convenience of computation, the north-south and east-west axis was placed so that all of the project would fall in the northeast quadrant. No attempt was made to correlate this grid system with the State Lambert grid system; however, later after the San Antonio Expressway system was expanded, ties were made to U.S. Coast and Geodetic Control points and from their geodetic positions, Lambert coordinates were computed. This was used, however, only for rough checking the survey base line for distances and bearings.

PRELIMINARY LAYOUT AND DESIGNS: After the general route of the proposed highway has been selected, from reconnaissance, study of aerial maps and other available data, a base line location along existing city streets is made, following as nearly as practical the general alignment of the expressway. Angle points in the line are numerous and the points are selected for longest tangents, ease of chaining, and safety of survey party members, instruments, and tape from traffic. Generally, 1 1/8-inch round by 30-inch long steel pins are used for these points, a center punch being used to establish the transit point. Wherever possible base lines are looped back on alternate routes for closure of the traverse. Angles are measured by repetition with a 30-second transit, with both exterior and interior angles turned six times. Angles are turned a sufficient number of times to check within two or three seconds. Measurements are made with a 100-foot, one-eighth-inch width, flat steel tape with the foot before the zero graduated in hun-

dredths of a foot. This tape, prior to use, is calibrated with a standard tape in order to determine its correct tension. All measurements are corrected to 70 degree Fahrenheit, the tape temperature being recorded at the time each measurement is made. The base line is measured from P.I. to P.I. over previously set chaining stations, forward and back, interchanging the tapemen, observer, and recorder for each one-way run. A special effort is made to do all base line work under most suitable weather conditions. An accuracy of better than 1:20,000 is usually obtained. The true bearings of the base lines are obtained by turning angles from previously established base lines or by observation of polaris. The coordinates of each P.I. and chaining station are then computed.

From the main base line, supplemental survey lines are run wherever necessary to secure complete topographic information along and adjacent to the proposed expressway. While not using base line survey methods care is taken to insure reasonable accuracy and wherever possible survey loops are closed.

From the base lines and "topo" lines thorough and accurate topographic surveys are made. The initial survey ties in by angles and distance survey monuments, property corners and fence lines, so that coordinates of these points may be computed and plotted. The survey lines and property topographic features are then plotted on pencil linen tracing cloth, to a scale of 1 inch equals 20 feet. From the information thus secured, city block lines, lot lines, and property lines are computed and plotted. On this preliminary layout, tentative right-of-way lines are drawn, based on the proposed expressway design. The work drawings are then reduced in scale by photographic methods and prints are furnished the city for their use in protecting the proposed right-of-way area until actual purchase can be made.

In the next stage of development, complete topography is taken in the field and plotted on the working drawings. All buildings, fences, utilities, pavements, and other physical features are carefully tied in to the survey lines. Field cross sections are taken and elevations and contours are then plotted on the working drawing.

Having white prints of the completed working drawing, the designer is then ready to begin work. Where no exact controls on alignment are necessary, coordinates of points on line are scaled from the working drawings and a bearing computed from the coordinates of the last control point. In many instances, it was necessary to establish coordinates of controlling building corners, and establish coordinate points on the main alignment to provide a minimum building clearance. By coordinate computations it is simple to compute a curve or tangent that would pass through the established control coordinate point. The completed expressway alignment is then plotted and coordinates are computed and assigned for all principal control points on all expressway, ramp, and street alignments and points such as the Center, P.C., P.T. and P.I. of curves, noses, bridge center line intersections, and many other points that assist the designer and the field engineer in laying out the project. By use of the coordinate method of calculation every computation can be closed by the computer to check calculations, as one would close a traverse, thereby eliminating the time and expense of an independent check of the work.

All calculations are carried to one-thousandth of a foot, and angles to the nearest second. Where major structures occur on curves the computation bearings are carried to the one-hundredth of a second in order to secure accuracy of one-thousandth of a foot for the bridge control calculations. Eight place tables of trigonometric functions published by the U.S. Department of Commerce are used in computations. With modern mechanical calculators these requirements do not increase computation costs.

RIGHT OF WAY: The staking of right of way presents a very perplexing problem. Right-of-way lines and points are required prior to clearing houses, buildings, debris, etc., from the construction site and the usual plus and offset method of staking from the construction center line cannot be done. Coordinate method of calculation and staking from base survey lines has been found to be the answer. From ties to city monuments, property corner pins, fence lines where necessary, and using the usual city block map or subdivision map, coordinates are computed for each right-of-way corner. Then from the nearest point on a base survey line,

or if necessary from random survey lines, by angle and distance, right-of-way points are set with speed and accuracy. In the event the right-of-way point does not fall in the property or fence line intended, it is evident that the property lines of possession do not agree with the recorded subdivision. If at a later date, the position of a right-of-way point should be questioned, it is a quick and simple matter to check the work, and if an error exists or an adjustment has to be made, the point can be reset quickly and easily. It has been proven that savings in survey and office work by this plan justified the slight cost and inconvenience that may occur when errors are found. No attempt is made to set right-of-way pins at each lot line, instead, points are set at the beginning and end of each city block and at each angle in the right-of-way line.

One of the most important and useful features of having coordinates on all right-of-way points is that the Expressway Engineer can be sure that sufficient right of way has been secured to contain all the expressway construction. By difference in coordinates, the engineer can quickly and easily calculate the distance from a retaining wall, edge of slope, bridge, or other control feature, to the nearest right-of-way line. Or, the designer may, by coordinate calculation, easily determine a minimum right-of-way width which will satisfy all construction requirements and at the same time use only the minimum amount of expensive city business or residential property.

CONSTRUCTION: Due to the magnitude and complexities of expressway construction, coordinate methods of calculations in the office and construction coordinate control have proved invaluable since it has been in actual use in the construction of the San Antonio Expressway from its beginning in 1947. The expressway contractor is usually ready to begin construction on portions of his project before the entire area has been cleared of obstructions, preventing the usual placement on the ground of the project control line. Even if the control line could be run in its entirety, construction operations would soon prevent its being used for construction control. As a result, portions of the project such as sections of continuous retaining walls, separated by streets which must remain open to traffic until other traffic facilities are constructed, must be staked out and constructed, leaving portions of the retaining walls which must tie together perfectly when completed. If one were to stake out all the controls for the expressway lanes, retaining walls, bridges, ramps, and storm sewers prior to beginning of work, there would be so many stakes the contractor would have no room to work. On a confined expressway project, the contractor needs every foot of working room possible.

From the base survey line, used on preliminary layout and surveys, construction base lines or coordinated control points are placed on the ground which will remain throughout the length of the construction project. From these points, by simple office calculations, it is quick and easy to stake out any portion of the project. This also is very beneficial to the contractor since he does not have to wait for roadway control lines to be rerun each time stakes are required for the various construction operations. For the Texas Highway Department, this system of calculations and controls is most economical, as fewer survey and office personnel are required. On our San Antonio Expressway we have under contract at this time two adjacent projects, 1.238 miles in length, having one 2,300 foot elevated expressway, five under-crossing bridges, and over a mile of retaining walls, estimated to cost $3,160,000. The entire field layout work consisting of all calculations, stakes, and construction lines and grades for roadway and structures are being performed by one office engineer and one five-man field party. From reference lines and points established by the survey sections, the Construction Inspectors and Instrumentmen are able to give the contractors quickly and easily the detail lines and grades for structure construction.

PLATE I - LOCATION MAP (URBAN AREA): This plate shows the first stage of expressway development in an urban area, the section being on U.S. 81 between San Pedro and Richmond Avenue. The survey line along Elmira and Richmond Avenue is an initial primary base line. From this base line additional survey or "topo" lines were run to tie in city monuments and available property corners. Coordinates are then computed on the block corners and all property information

is plotted on the 1 inch equals 20 feet scale pencil tracing cloth working drawing. After design studies; a tentative or preliminary right-of-way line is drawn on the location map as shown. Reduced prints of this drawing are furnished the city to prevent right-of-way encroachment.

PLATE II - LOCATION MAP (SUBURBAN AREA): This plate is also the initial construction layout or working drawing of an expressway project, but is located in a suburban area where extreme accuracy is not required. The random transit line is first laid out on 1 inch equals 200 feet scale aerial map to miss existing houses, barns, heavy clearing, and in some instances cultivated fields with growing crops which a survey line might damage. The field survey line can then be run following the aerial map line. From this base line all existing topography is tied in and plotted on a 1 inch equals 40 feet scale pencil tracing cloth working drawing. The right-of-way line is established as shown by this construction layout, and reduced prints are furnished the governing agency to prevent right-of-way encroachment.

PLATE III - TOPOGRAPHIC WORK SHEET: This is a representative topographic work sheet on which all existing topography and elevations are plotted, and covers the same area as shown on Plate I. For this illustration all elevations which are usually placed on the work sheet are omitted, except for the contour lines as shown. This plate also shows an important building on the west side of Main Avenue which was tied in accurately so as to provide safe clearance for the expressway construction. The designer works out on prints of this drawing all design, layout, and right-of-way calculations.

PLATE IV - CONTRACT PLAN LAYOUT SHEET: This plate also covers the same area of expressway as shown by Plate I, the preliminary construction layout, and Plate III, the topographic work sheet, and represents a layout sheet from the completed contract plans. It will be noted that much preliminary information has been omitted in the preparation of this sheet, for the reason that for contract purposes it is not considered essential and would detract from the principal construction features. The field engineer though, in laying out construction, must frequently refer to and use the completed working drawing.

PLATE V - COORDINATE WORK SHEET: The San Antonio Expressway office has prepared many calculation forms for use by the computor in simplifying coordinate calculations. This picture shows a form used for the majority of simple calculations. The example shown on this form is an actual calculation taken from our file and illustrates a check of coordinate work by closing a traverse, as some of the distances were actually used by the survey party in staking a retaining wall.

PLATE VI - COORDINATE WORK SHEET: This calculation form was prepared to simplify the work necessary to find the coordinate of the intersection of two straight lines having given a coordinate and bearing of each line. This particular type of calculation is used many times during the course of design and construction, and can be accomplished very rapidly using an electric calculator.

PLATE VII - SAMPLE CALCULATION FORM: To assist the beginner in coordinate calculations, and to refresh the memory of the old timers, forms have been prepared showing how to solve various problems that arise during computation. This plate shows the method of solving for the intersection of a curve and a straight line, and the intersection of curved lines, a calculation usually necessary to solve for the location of ramp and expressway noses.

PLATE VIII - SAMPLE CALCULATION FORM: The sample calculation form was prepared to show a method of solving for the intersection on a spiral or transition curve, and a straight line and the intersection of a spiral curve and a circular curve. It will be noted that this sample involves a method of several trials, which will give a result within the accuracy required and eliminated the use of complex equations.

CONCLUSION: No attempt has been made in this paper to show the actual details of construction and design calculations or the details of surveying, but rather to show in general the San Antonio Expressway method of using coordinates to simplify the phases of design, project development, and construction. While there are many other methods of layout and calculations, it is believed that by the use of coordinates the work may be done more easily, more accurately, and certainly more economically.

DISCUSSION •

Of G. S. Meyer's Paper

O. G. Rayner, Supervising Urban Engineer
Dallas Expressway Project
Dallas, Texas

You have heard what I consider a most excellent and timely description of the use of coordinates on urban highway surveys. I am in substantial agreement with all the statements contained in Mr. Meyer's paper. The Dallas Urban Expressway office is currently engaged in setting up a coordinate system for use in the location of the Dallas - Oak Cliff and East-West Expressways, and the information obtained from this paper will be invaluable in our work.

The use of a coordinate system is a must in most urban highway surveys where the center line frequently crosses city blocks diagonally and rights of way are purchased at costs upward of $3 a square foot. Where the razing of large buildings is involved, the cost can be considerably more. Right-of-way cost is the most important factor in urban construction, in some instances, exceeding the entire construction cost. Since rights of way are furnished by the cities, considerable delay can be encountered due to their inability to finance the purchases. Such is the case with the City of Dallas.

A coordinate system provides the urban engineer with a method of accurately determining the right of way required and its exact location on the ground. This, with our present knowledge of urban design standards, will make it unnecessary to go back for

additional right of way, which is always an unpleasant and costly procedure. It will also assist in the obtaining of the minimum right of way required consistent with adequate design. In accomplishing the above, the right-of-way cost will be reduced with a resulting speed-up of the urban program.

The Dallas Expressway work in the past has been limited to Central Expressway which was located along an existing railroad; and consequently, in most instances, a clear center line was obtainable. A coordinate system was not considered necessary. However, in view of the difficulties encountered in right-of-way procurement and during construction, such a system would have paid dividends.

In starting a survey, one of the first questions to be resolved is the degree of control to be exercised. Once the degree of accuracy has been decided, any work within those limits should be accepted as satisfactory. Considerable time can be expended attempting to raise the control to a higher accuracy. A reprint from Surveying and Mapping, Vol. XI, No. 4, of October - December 1951, "A Policy on Highway Surveys," prepared by a special committee of nine highway engineers of the Surveys Division of the American Con- ommends the following:

First Order Accuracy - For use in surveys involving major bridges, long tunnels, and all structures of such size and importance as to justify geodetic surveys: The requirement for distance is 1 part in 25, 000; the probable error in main scheme angles shall not exceed 1. 5 seconds; and the error in leveling not to exceed 0. 017 foot times the square root of the length of section in miles.

Modified Second Order Accuracy - For use in surveys including expressways and interstate highways through the urban areas of the larger cities: The requirement for distance is 1 part in 10, 000 or 0. 01 foot per 100 foot tape. The angular error shall not exceed 20 seconds times the square root of the number of angles between tangents of the traverse. The error in leveling not to exceed 0. 035 foot times the square root of the length of check section in miles.

Modified Third Order Accuracy - For use in surveys involving primary and interstate highways outside the urban areas of larger cities: The requirement for distance control is 1 part in 5, 000 or 0. 02 foot per 100 foot tape; the angular error not to exceed 40 seconds times the square root of the number of angles between tangents of the traverse; and the error in leveling not to exceed 0. 05 foot times the square root of the length of check section in miles.

It is to be noted that the above are minimum requirements and in the case of modified second or modified third order the degree of accuracy specified can be achieved or exceeded with the equipment in the Resident Engineer's office. By the use of a standard minute transit in good adjustment, repeating angles four or more times and estimating the readings to the nearest half minute, on both verniers, angles can be measured within 15 seconds. Since any error involved is accidental (just as likely to be over as under the correct angle) the total angular error should be well within the angular requirement. The distance requirement is more difficult to attain due to the common errors in chaining. Quite frequently under usual conditions, when a center line is rerun for construction, it is necessary to place equations in the line (usually at P. T. of curves) of a magnitude varying from a few tenths to several feet. Two types of error arise in chaining, systematic errors and accidental errors. Systematic errors include the tape not being standard length, incorrect tension applied to tape, and use of a tape suspended when standardized for full support. The last item is the most important in the group and can result in an error of 0. 3 tenths per 100 foot. The standard tape used in highway work is standardized at 68 degrees

Fahrenheit supported for its entire length with a ten-pound pull. So far, I have been unable to find any information concerning the pull required to offset the sag to produce a 100-foot length. Of course, knowing the cross section of the tape and the weight, the pull can be calculated so as to make the shortening from sag equal to the elastic stretch. However, probably a more satisfactory method is to measure a 100-foot distance with the tape fully supported at ten-pound tension with temperature correction and then determine the pull necessary with the tape suspended to measure the 100 feet. Tapes may be sent to the Bureau of Standards for almost any standardization that is desired. The necessary information is contained in any of the surveying instrument catalogs. Temperature correction amounts to 0.01 foot per 100-foot tape for a 15 degree temperature change. Accidental errors include improper alignment of tape, tape not horizontal or correction not applied for slope, and improper plumbing. Should all of the above errors be in the same direction, it is possible to have an error of as much as 0.5 foot per 100 foot. I mention the above to impress upon you the necessity for considering all possible sources of error if modified second- or third-order work is to be achieved. Of course experienced instrumentmen and chainmen are a necessity.

I have here a city engineer's standard tape that is being used on the primary traverse. This tape is standardized at 68 degrees Fahrenheit, supported at each end. The spring balance consists of two telescoping nickel silver tubes connected by a strong spring. The inner tube carries the spirit level and tension mark, and the outer one carries the thermometer. All that is necessary in the use of this tape is to set the temperature correction. This tape is periodically checked against a standard tape at S. M. U. and so far has consistently run 0.003 foot short which is approximately 1 in 30,000.

Local systems of coordinates have been extensively used for many years. From 1903 to 1908, a local system of coordinates was established in Greater New York City. Due to the difficulty in obtaining the required accuracy in the fringe areas from the central origin caused by the curvature of the earth, three separate local systems were used. Today, by use of the New York State Coordinate System, an accurate survey of the entire area could be referred to a single grid.

In 1933, a coordinate system was established in North Carolina at the request of the State Highway Department by the U. S. Coast and Geodetic Survey which utilized the geodetic data over the entire state and involved only the formulas of plane surveying. Subsequently, systems have been established for all states. Two systems are used. The transverse Mercator's projection is employed for states having limited east-west dimension while the Lambert projection is used for states having limited north-south dimension. The Lambert projection or grid is used to divide Texas into five zones running east and west across the state. This projection may be exemplified by a cone cutting the surface of the earth along two parallels of latitude situated about one-sixth of the width of the zone from its northern and southern boundaries. The cone is considered as cut along an element and flattened into a plane carrying with it the parallels and meridians, which have been projected onto it. On this developed surface, a grid is imposed with the Y axis parallel with a central meridian and the X axis below the southern limit of the area. It will be seen that distances measured on the grid between the cut parallels will be less than the geodetic length since the grid in this area is below the sea level surface of the earth while the grid lengths outside this area will be greater than the geodetic lengths. Geodetic lengths are measured along the surface of the earth at sea level. A width of 158 miles has been adopted for the grid which provides for a maxi-

mum error between grid and geodetic length of 1:10,000. For Texas, the scale ratio is slightly above 1:10,000, which permitted the state to be divided into five zones. Since distances are measured along the earth's surface, it is necessary to reduce them to geodetic or sea-level distance before utilizing the Coast and Geodetic data. This can easily be accomplished by obtaining the scale factor for the elevation of the area involved and can be likened to running the right-of-way line on the inside of a curve where the measured distance along the center line is reduced. In changing from geodetic to grid length and vice versa, the length is multiplied by the scale factor for the area. The above scale factors can be obtained from the publications, "Plane Coordinate Projection Tables, Texas (Lambert)," available from the U.S. Coast and Geodetic Survey, Washington 25, D.C., and the "State Coordinate Systems" (A Manual for Surveyors), available from the Superintendent of Documents, Washington 25, D.C.

The Coast and Geodetic Survey publish information concerning each of their triangulation stations and also the plane coordinates, azimuth and grid angles for use in the Lambert Grid. Since the Geodetic North and Grid North coincide only at the central meridian, it is necessary to apply a correction to the Geodetic North to obtain the correct Grid North.

So far, the coordinate work in Dallas has been confined to the running of a primary traverse between two triangulation stations in the vicinity of the expressway location. The traverse is approximately ten miles and contains 33 angles. The traverse was closed with an error in distance of 0.44 foot and an angular error of 33 seconds or one second per angle. This results in an error of approximately 1:100,000. In this case, we consider it a lucky break as we did not anticipate this degree of accuracy. On future primary traverses, we hope to obtain an accuracy of 1:20,000 for distance and an angular accuracy of ten seconds times the square root of the number of angles.

Once the primary traverse is balanced, it will be necessary to convert the distances from grid to ground level distances with a corresponding change in coordinates due to the fact that right-of-way procurement and construction measurements are based on ground distance. This, in effect, will require the use of an independent system of coordinates accurately anchored to the Lambert Grid.

In utilizing the information furnished by the U.S. Coast and Geodetic Survey, an economy is effected in that the primary traverse can be closed by checking into the triangulation stations which will preclude the need of running the traverse to the point of beginning and provides an independent check on the work. Currently, the primary traverse is costing approximately $300 per mile. Also, the grid is capable of extension to any part of the country with the same accuracy as at the point of origin which permits the re-establishment of any number of destroyed points or corners with accuracy.

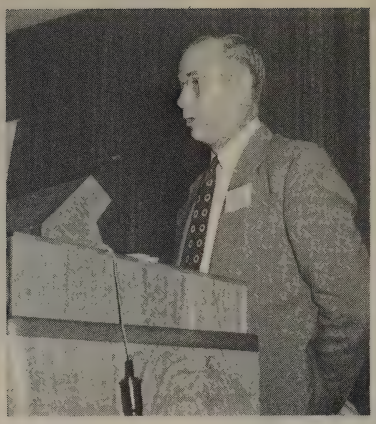
So far, no mention has been made of the use of coordinates during construction. Certainly, they should be used at street intersections, selected points on the center line, ends of structures, and other points before the right of way is cleared. It is not too difficult to envision in order to get our foot in the door on a new expressway construction that we will be required to start construction on the ends of a long elevated structure before the in-between right of way is cleared. In this case, coordinates would definitely be used. However, after the center line is cleared just what control should be exercised by coordinates is a debatable question. I am still old fashioned enough to believe that the conventional method of staking from the center line or right of way might be the most economical and the one less apt to produce errors.

Intermission finds Marshall Formby, T.H. MacDonald, E.H. Thornton Jr., M.T. Harrington, Gibb Gilchrist, and D.C. Greer gathered together.

Jim Douglas, H.S. Hudson, R.E. Killmer, and A.C. Gentry exchange greetings during intermission.

Carl A. Grau, Fred T. Bennett, and Harvey Deen in serious discussion.

B.B. Freeborough, Tom H. Taylor, R.L. Schmidt, and W.H. Shaw exchange views.



PRESTRESSED CONCRETE

James R. Graves, Senior Designing Engineer
Bridge Division
Texas Highway Department
Austin, Texas

INTRODUCTION: The engineer is being introduced to a new structural material, prestressed concrete. This new idea in concrete is undergoing the slow and painful birth that reinforced concrete experienced about 50 years ago. Here at last is a concrete material that can compete with structural steel in long-span bridges, and during wartime steel shortages this will be of great importance. In Europe today it is showing economy over structural steel in bridge spans of 250 feet and more. Prestressed concrete requires much less concrete and steel than are required in reinforced concrete for equal spans, and this reduction in dead weight is a real gain. Prestressed concrete is not intended to replace reinforced concrete, but rather to work with it like a big brother.

DEFINITION AND EXAMPLE: Prestressed concrete can be defined as the introduction of a favorable stress condition into a concrete member before working loads are applied, so that tension will not occur in the concrete under any loading condition. Or it may be thought of as a system of reverse loading in which compressive stress is created in the concrete in the areas where working loads will cause tensile stress. A simple example will be given to illustrate this. Assume a rectangular concrete beam, used as a simple beam supported at each end. A normal loading of this beam will produce a moment which will cause compression in the top and tension in the bottom, of say 1,000 pounds per square inch. But concrete alone has no ability to take this tension, so assume that through the center of this beam a high tensile wire is introduced. Now tensile stress is jacked into the wire and it is tied off and anchored against the ends of the beam. This prestress loading when considered alone creates a uniform compressive stress across the entire beam cross-sectional area, and in this case is assumed to be 1,000 pounds per square inch. When this prestress is combined with the beam working stress, there is a new resultant stress pattern of compression across the entire beam cross-sectional area, varying from zero at the bottom to 2,000 pounds per square inch at the top. This is prestressed concrete in its simplest form, and represents its normal working condition--compression across the entire cross-sectional area under all conditions. It is this condition which produces crackless concrete, and takes full advantage of concrete's great compressive strength.

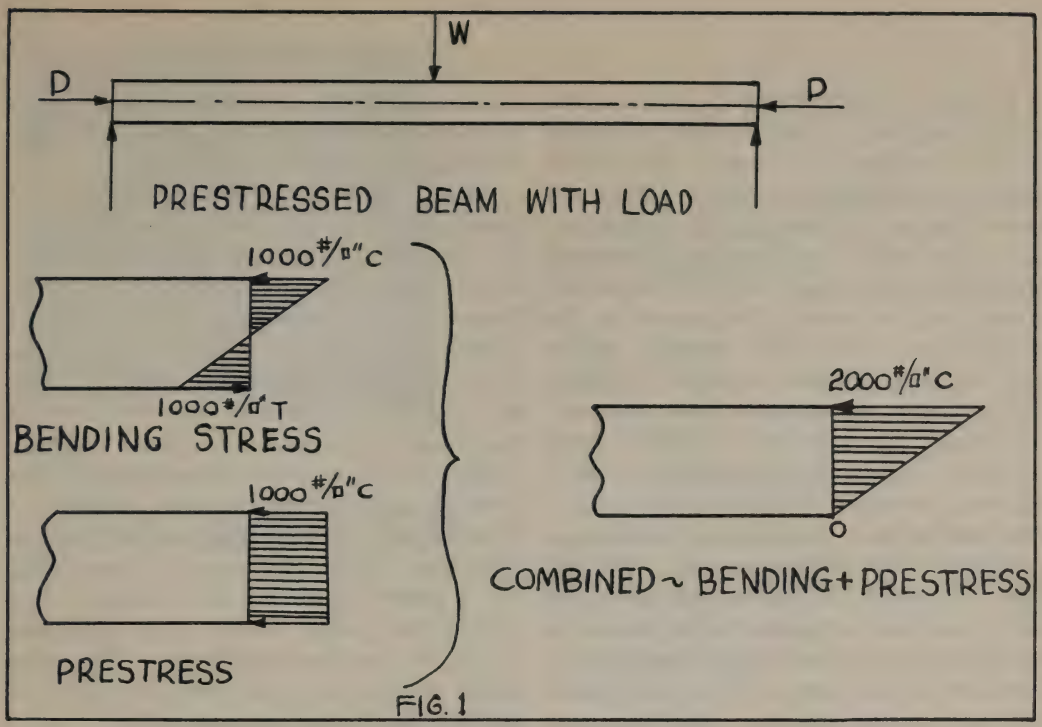


FIG. 1

DESIGN FEATURES: The prestress steel can be varied in location and shape so as to give the maximum benefits. The wire in the above example could have been placed near the bottom of the beam so as to have given a pattern of more stress at the bottom and less at the top of the beam. Or the steel may be placed in a parabolic curve throughout the beam so as to gain even more advantage. In design the stress pattern due to prestress is first determined and then the member is treated as any homogeneous structural member. In other words, the concrete stress in a beam due to normal loading is equal MC/I for any section, and this stress is algebraically added to the prestress for the final stress. Shear and diagonal tension stresses are much less serious in prestressed concrete and web reinforcement is often not needed. Figure 2 shows a typical prestressed beam as found in actual practice with its stress patterns. Prestressed concrete has great flexibility in its application, and the possibilities of its use are many.

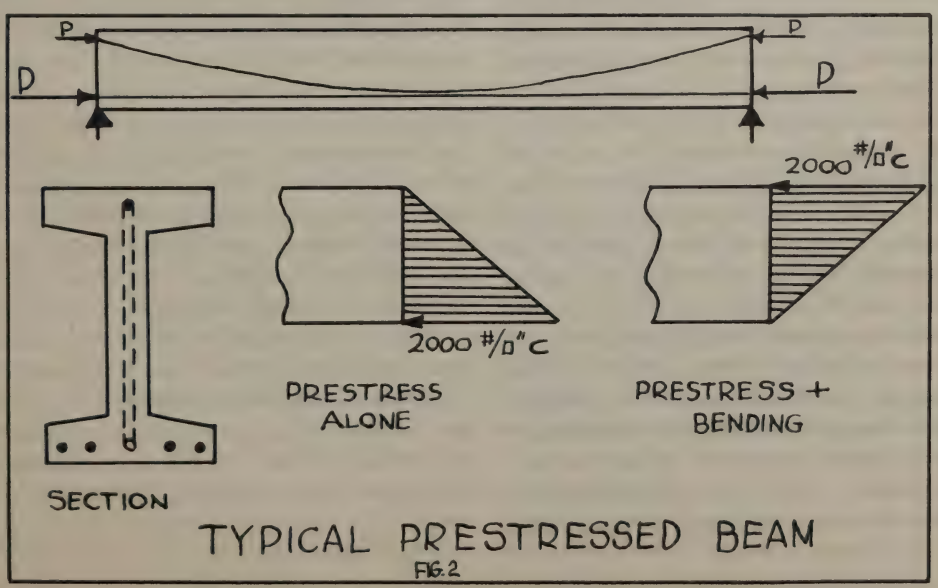


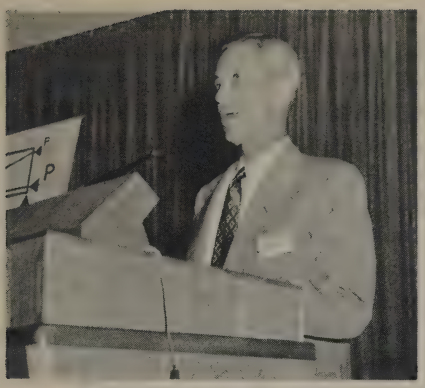
FIG. 2

SPECIAL REQUIREMENTS: There are several requirements which must be met in the use of prestressed concrete. The first of these is a high quality concrete with an ultimate strength of about 5,000 pounds per square inch which can work with adequate safety factor at a stress of 2,000 pounds per square inch or more. The second is the necessity for a very high strength tensile steel with an ultimate strength of about 200,000 pounds per square inch that can work at a stress of approximately 120,000 pounds per square inch. This high strength steel is necessary because of the loss of steel stress in prestressed concrete members due to shrinkage and plastic flow of the concrete. This will produce as much as 20,000 pounds per square inch stress loss in the steel which would be serious in any other than the high tensile steel. There are several types of high tensile steel used in prestressed concrete. The three most common are bridge strand, cold-drawn parallel steel wire, and high-strength steel bars. There are many types of anchorages, such as the socketed end on the bridge strand, the wedge type for the steel wire, the tapered thread on the steel bars, and the upset end of the steel wire.

PRESENT APPLICATIONS: Precast concrete can be used anywhere reinforced concrete is used, and beyond the limits of reinforced concrete. It has been used extensively in Europe since the end of World War II and has produced a great many long-span bridges. In the United States it has been used in bridge spans, building frames, circular storage tanks, street lighting standards, concrete pipe piles, and other structures. It is used in both precast and cast in place members. The concrete can be cast around pretensioned wires, depending on bond to the concrete to deliver the prestress. This is called pre-tensioning, and is essentially a factory process. Another method, and the most common, is to cast holes in the concrete member and place the steel here unbonded to the concrete. After the concrete member has attained sufficient strength, the prestress is jacked into the member, and the steel anchored against the ends of the member. This is called post-tensioning. Prestressed concrete is used in continuous spans as well as in simple spans, and there is evidence that it may someday be used to advantage in concrete pavements.

ECONOMY OF USE: The savings in prestressed concrete can amount to as much as 50 per cent in both concrete and steel when compared with reinforced concrete. However, the materials in prestressed concrete will show a higher unit cost. The over-all cost of a prestressed concrete structure must show economy, otherwise there is no reason for its use. The Texas Highway Department has built one experimental prestressed concrete bridge span, located in Austin County on State Highway 60 over the San Bernard River. This span is 60 feet long, has a girder depth of only two feet, used galvanized bridge strand in a parabolic curve, and was post-tensioned. This same girder section will span only 30 feet as an ordinary reinforced concrete unit.

FUTURE OF PRESTRESSED CONCRETE: Prestressed concrete has been especially adaptable to the conditions existing in Europe; that is, an oversupply of skilled labor and a shortage of structural materials. In this country for the past fifteen years construction has been on such a boom that prestressed concrete has had difficulty breaking into the field. Probably the most important factors in the successful use of prestressed concrete in this country are involved in the type of high tensile steel used, and the method of anchoring this steel. New ideas and methods for handling the steel are being developed at the present time, and this may be the key to extensive use of prestressed concrete. There is a real need for a long-span concrete member that can be used in the coastal areas in lieu of steel I-beams. Precast and prestressed concrete members used in a manner similar to steel I-beams may be the answer to this very difficult problem. The challenge is here for American engineers to develop a construction procedure that will produce economical structures from this material. The idea of prestressed concrete is so simple and so adaptable that there is no doubt that in the near future it will be used with the same ease that reinforced concrete is now used.



B. A. Trice, Vice-President and Chief Engineer
Harry Newton, Inc.
Graham, Texas

Discussion • OF J. R. GRAVE'S PAPER

I am very glad to be on the program this morning, and particularly so since the subject assigned is one of which very little is known. Such subjects always offer unlimited possibilities with little chance of embarrassing questions afterward. Prestressed concrete is advancing rapidly through the stress computation stage, however, and there are a dozen or so persons here who are well conversant with it. Insofar as stress computations are concerned, these people know it upside down and backwards. I contend that I, too, know it upside down and backwards. The difference is that some of these other people also know it right side up and forwards.

But as to the construction and performance of prestressed structures the knowledge so far gained is scant and may continue to be so for some time to come. This knowledge will come only through experience, and so long as experience is lacking the designer will have hard going. He can't sell an untested design and he can't test it until he sells it. But this dilemma did not originate with prestressed concrete. Reinforced concrete faced it and so did synthetic rubber. So also did nylon.

The problem is well put by Mr. Graves in his last statement. Here are two materials well known and proved and here is an idea for combining the two with substantial savings in materials. Our problem is to convert these savings of materials into savings in cost. How far we have progressed is indicated by these figures: Reinforcing steel for reinforced concrete is currently bid in place at from 10 to 12 cents per pound while high-tensile steel for prestressed concrete is going at from 60 cents to $1 per pound. Concrete for prestressing goes at from $100 to $150 per yard while concrete for reinforced concrete is bid at from $39 to $60 per yard. These often combine to indicate prestressed concrete to be about equal in cost to reinforced concrete or steel. The extremes range from cases in which prestressed concrete is definitely indicated to the opposite extreme in which it is definitely not indicated.

Such a condition does not favor the increasing use of prestressed concrete. A new product must offer some advantages if it is to remain on the market. Many a person is willing to buy a trial package but if the trial shows no definite advantages he will buy no more of it. The general rule is that a product must be either better or cheaper. There are instances where prestressed concrete will serve the purpose better than its competitors but these instances are relatively few so that we may say that prestressing must sell itself be being cheaper.

And it ought to be cheaper. Why must a contractor bid a dollar a pound for wire which he can buy delivered to the job for 18

cents? And why must he bid $150 a yard for concrete which he can get delivered for $15? The contractor is being paid 80 cents per pound for handling and placing wire and $135 per yard for forming, placing, handling, and curing concrete. Substantial reductions are necessary if prestressed concrete is to be generally competitive. I will point out four factors which influence these costs:

1. Prestressing is new. A few contractors have had some experience with it but to the majority the method is new and therefore requires a certain factor in the bid which will offset possible unseen difficulties. This factor is sometimes higher than is necessary because the contractor doesn't enter into the development of new things with the same objective as the designer — he is a pioneer only when forced to be. Our firm has had a little experience in the furtherance of new methods and these have been a source of real pleasure and enthusiasm to Mr. Newton. Whether or not his enthusiasm is shared by his banker would possibly be of interest but it would also be, as the saying goes, beyond the scope of this paper. The engineer and the owner may, therefore, expect only nominal cooperation from the contractor at the time bids are taken. The average contractor endorses progress, favors a sound economy, and takes proper pride in a job well done. But he registers his greater passion over the difference between his bid price and his costs.

2. End anchorage of prestressing steel to concrete is difficult and expensive. Here a material carrying a stress of over a hundred thousand pounds per square inch is tied off to a material which can carry two or three thousand pounds per square inch. This must be accomplished in a limited space and the process is repeated thousands of times in the average sized job. Many methods have been developed. All require special gadgets and/or special machinery and most, if not all, are protected by patents. The royalties which must be paid to the holders of these patents are not prohibitive but the machinery, hardware, and on-the-job labor costs, when added to the royalty payments, make up a sizeable item. All of these methods perform fairly well but none of them are good enough. There is a real need for a better end anchorage method — one which is easy of application, positive acting, and which will not require tools and hardware of special manufacture. The developer of this method should deliver his idea, free of charges and encumbrances, to the industry. But such magnanimity will not be found. There are a number of firms and individuals presently working on this problem and I believe that a new and better method will soon be developed. When it is, the cost of prestressed concrete will be appreciably reduced.

3. Forms for prestressed concrete present a special problem not found in ordinary reinforced concrete. The reason for this is that prestressed concrete is a homogeneous material and is therefore most economical when used as H-beams, hollow box sections, and other shapes such that all of the sectional area is moved as far from the centroid as possible. Forms for such sections can be made of wood but the cost of these forms per yard of concrete is high. Steel forms can also be used successfully, but new techniques of design are needed if costs are to be substantially reduced. We recently worked out a design which appeared to have promise and we are using it on a project now under construction. The results are satisfactory but not convincing.

I believe the answer to this phase of the problem lies in assembly-line production of precast, prestressed units. The setup for such production with provisions for accelerated curing, forms, and casting and handling equipment would run into round figures and would need the assurance of a substantial volume of business before it could be undertaken. In the absence of such assurance, it could be launched only by a man of extreme optimism backed by a crazy banker. The Highway Department is now considering a major bridge project on which prestressed concrete would be given a chance to compete with other materials. This would be an opportunity for some contractor to develop a precasting plant if the design can be worked out within competitive range of other materials.

4. Transportation and handling of prestressed concrete is difficult and expensive unless considerable thought is given to the weight of the individual units. We have usually found that casting in place is slow and tedious and presents so many problems that it is seldom worth considering. If the units are

precast they must be hauled to the site and set in place with the nominal equipment which the contractor can afford to place on the average job. Such equipment can handle loads of 12,000 to 15,000 pounds at a reasonable working radius, but if the load exceeds this weight by any appreciable amount much heavier equipment must be used and the cost of handling goes up sharply. Units weighing less than 15,000 pounds can be used for a large amount of highway work, however. For instance, a bridge deck for 60-foot spans can be made of such units if lightweight aggregate is used and if sections are held to the necessary minimums.

This discussion might appear to be an attempt to show why prestressing will not work, but such is not what I have intended. I do believe prestressing will work but we must recognize some of the more serious obstacles in its path of development. And we will have to overcome these obstacles by the use of new methods, procedures, and devices. The problem is, at present, in the hands of the designer but he will need the suggestions and close cooperation from the contractor if he is to succeed.

And this brings us to a concluding remark which is applicable to other phases of building as well as prestressed concrete. Relations between the Texas Highway Department and Texas contractors are good, but liaison work between the two groups could be extended with profit to all. The engineer doesn't realize how little the contractor knows about engineering and the contractor doesn't realize how little the engineer knows about contracting. I would not suggest formal liaison work. I suggest hundreds of informal meetings in groups of two, one engineer and one contractor, where information is given and taken freely and where side issues can be avoided. Such meetings will produce better design which can be built at lower costs to the state and they will lead to fewer losses by the contractor, which will enable him to require less profit.

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H.S. Gillette, Bureau of Public Roads, participates in a floor discussion.

Discussion

OF J.R. GRAVE'S PAPER

P. V. Pennybacker, Supervising Field Engineer
Bridge Division
Texas Highway Department
Austin, Texas

Mr. Graves has presented the theory of prestressed concrete well. We know now what makes this type of construction possible. It is high-strength concrete and high-strength steel. With these materials of construction available the designs are possible. Whether or not the resulting structures will be economical and whether or not they will actually be constructed to perform as the designer intended them to are to be answered in the future.

Unless they are economical they will not be generally used. And unless the construction involved is interesting to more than a very few contractors, competition will not govern the bid prices. Portland Cement concrete of any required strength is competitive. The several types of high-tensile steel and the anchorage details for each type are covered by patents and are not competitive unless the design drawings permit the use of any of a number of types. The actual stressing of the rods, depending on the type used, may have to be done by licensed specialists, which further reduces the element of competition and makes the contractor's schedule of operations dependent upon an outsider.

I have the impression that the proponents of prestressed concrete for highway bridges feel that this field begins with about 40-foot spans and is strongest in the range from 60 to 85 feet. And I believe we all feel that the units must be precast and stressed before erection. In order to not require contractors to buy special handling equipment for erecting these precast units the designer must keep the weight of the individual pieces down to the capacity of equipment which our bridge contractors use regularly; otherwise competition is reduced.

When bridges of these span lengths are built provision for contraction and expansion due to temperature changes is necessary, and shoes of structural steel seem to be required just as would be the case for spans of steel beams or girders. The item of maintenance of structural steel is not entirely eliminated and a troublesome construction item is made slightly more complicated.

The interest of this group, so far as prestressed concrete is concerned, is for highway bridges. We must not lose sight of the fact that many such bridges will be widened at a later date and all must be maintained. If provision is made for future widening in the details of current construction the life of those confronted with the problem of future widening will be made less burdensome.

Thought should be given to what character of maintenance repairs these prestressed units may eventually require, and an answer found at the time of detailed design to the question, "How are we going to fix it?" Our experience with every type of structure indicates that each has its own peculiar problems of maintenance. Prestressed concrete will not be an exception.

These prestressed concrete spans are to be competitive with our continuous steel beam spans and continuous steel girder spans. They lack one element of adjustability which the steel units do have. We do occasionally have piers constructed out of position anywhere from one inch to ten inches. With our practice of field welding the shoes to the beams or girders an error in position of an interior pier is not bad. An error in position of an end bent can be taken care of by cutting or by welding. These errors in position of piers are generally discovered as the steel is being erected. The mistakes in pier location DO happen to us. Our current details with steel structures enable us to handle them in stride. They are problems which the proponent of prestressed concrete is going to have to learn how to handle.

This type of construction, once a contract is let, requires constant, capable supervision of the manufacturer, stressing, and erection of the concrete units. The supervision may be provided by the contractor or by the Resident Engineer, or by both, but the knowledge required is a specialty and supervision must be ever-present. I know that if this work is truly competitive we will have contractors on some projects who are not able to supply this supervision. I also know that many of our residencies are, for various reasons, not to be depended upon to provide the engineering supervision which is really the Department's responsibility. Under such circumstances I recommend to whoever has ultimate responsibility for these prestressed concrete bridges that proper construction supervision be guaranteed before each project goes to the design stage.

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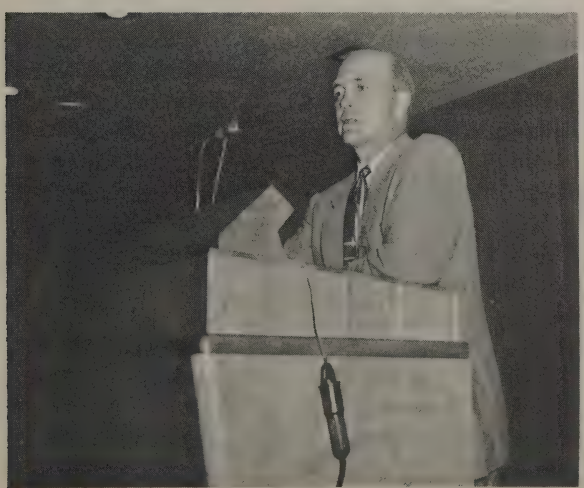


A.W. Eatman discusses the District Laboratory. A copy of Mr. Eatman's speech was unavailable.

FORMING A FARM-TO-MARKET ROAD PROGRAM

G. A. Youngs, District Engineer
Texas Highway Department
Atlanta, Texas

With a few exceptions the program this year is made up of speakers new in the particular position they now hold—freshmen in their jobs. Freshmen are usually green enough to say what they think without thinking of how elementary or maybe even absurb it probably sounds to the upper classmen. I got in trouble many times here at A. & M. 30 years ago when, as a "fish," I sometimes felt like expressing an opinion. My opinions on this subject are probably as crude as some I had on other subjects 30 years ago, but I have been asked to give them this time. This description of forming a farm to market road program follows the pattern used in District 19. It may not be the best method, but it has been used with success in that area.

At first thought the forming of a farm to market road program might appear quite simple to the tyro. All you have to do is list a number of projects in each county sufficient to use up all the money you've been allotted and send it in sometime before the deadline which has been set. There's really nothing to it until you begin work on it. Then wonder how much money or how many miles you should build in each county, which roads should be built to best serve the public, and if these are selected will they provoke opposition or meet with the approval of the County Courts in your District? After all, a county could veto any road by simply refusing to secure right of way for its construction. Then you begin to wonder just how to tell which roads will best serve the public; you wonder just how to evaluate the contradictory evidence presented by numerous delegations which have called on you, the myriad of letters you have received, and the intriguing antics of certain members of county courts, chambers of commerce, city governments. All of them have a pet project which, according to them, "should be built." Some are meritorious. Some have no potential value at all, yet you can't blame anyone for asking for the road. To the person who lives on some little sandy trail, it is more important than the Pennsylvania Turnpike.

You soon realize the forming of a program can be broken into two general phases, neither of which is too simple. First you should decide how the funds are to be allotted to the counties in your district. Next you must decide on the actual projects you should include. Then to further complicate the picture in both of the above general headings, you should decide whether any work is necessary on roads which were designated under some prior program. If so, should funds for this work be cut from the total allotment before distributing the remainder to the counties for new construction? From the inquiries I've made, it appears that general practice is to deduct from the district allotment those funds which will be used for other than new Farm to Market Roads before the distribution to counties is made.

I. ALLOTMENT OF FUNDS TO COUNTIES: The first general subdivision of program formation, the allotment of funds to counties, seems to present a number of problems (based on the varied practices which

are followed in different districts). Following are some of the methods which are being used:

1. Allocate state and federal funds, on a total accumulated basis, in proportion to the allotted miles in each county. This assures a money distribution in proportion to ultimate miles of roads, and it automatically makes allowances for funds which have been furnished by the counties in the 75-25 or other cooperative programs. It does not take into account the roads which have been taken into the system and which were originally constructed by the county to such standards that little or no additional funds were required.

2. Allocate funds in proportion to the remaining allotted miles not designated. If any one method had to be used, this simple formula probably should be the one. It would tend to make every county complete its program at the same time. It would not, however, integrate the factors of county participation and roads taken into the system built by the county or other agency. This method takes into account differences in local construction costs on all projects previously built, but makes no provision for this factor in the current program. This probably has some advantages.

3. Another method is to select roads which will tend to equalize the percentage of allotted miles in each county which have been designated. This method, if followed without modification, would bring the district program to a conclusion in all counties simultaneously. It takes into consideration the difference in construction costs in each county, but it fails to give credit to counties in which there have been cooperative programs or in which roads have been taken into the system with little or no cost. The counties which have contributed funds or roads will have been contributing an acceleration of the program to every other county in the district.

A combination of the last two methods making allowances for county participation and with possibly a subconscious integrating of other factors difficult to analyze or even state, is probably the method most District Engineers use. This means, in effect, that regardless of local costs, in the long run the counties will be kept reasonably close together in the percentage of their allotted miles designated, except some allowance (in the range of 5 per cent to 10 per cent ahead of the district level) will be made for counties which have made contributions to the system. It is believed that this method is the implied preference since distribution to the districts at the state level considers, among other things, the local construction cost factor; and when a district or county is far ahead of the state average in percentage of its allotted miles designated, funds are held back from that district and distributed to the funds of each other district. In any event, there will always be some variation in each district at any given time from any set formula or method of distribution. This is because the projects selected will not always exactly equal in construction cost the computed distribution.

II. PROJECT SELECTION: After the allotment of funds to individual counties is made, the second general phase in forming a program is begun, the SELECTION OF PROJECTS. This, too, should be broken down into two general headings: The Preliminary Selection and the Final Selection, which is the program to be submitted.

A. THE PRELIMINARY SELECTION OF PROJECTS: The Preliminary Selection of projects involves a continuing process in that a selection is always being made, revised, observed, weighed, discarded, reformed. This action is a continuing duty of a District Engineer and not just something he begins after receiving word that a new program is to be formed.

There should be kept in each district a complete list of "potentials" in proper order of priority. If these differ from the official "suggested

additions" of the Planning Survey, the District Engineer should be prepared to justify them. In order to prepare such a list, familiarity with the county roads in the district which are now, or are likely to be, potentials is of prime importance. It must now be decided too, what factors contribute to the relative importance of roads. On this subject there is as wide a difference of opinion as there is in the methods of alloting funds to counties.

Certainly, accurate traffic counts are and should be the most important factor in deciding relative importance of roads. The number of feeder roads, or branches from a road, are good indications of its future importance. The number of occupied residencies along a road, whether or not there is an REA or commercial power supply to the area, the inaccessibility of the area, or the road's value as an access road to certain activities are good yardsticks to use in determining relative values. Regardless of what standards are used TRAFFIC is the ultimate measure of its importance. Occupied residences, power supplies, all other factors are good, but if the people who occupy the residences do not travel on the road, they do not need it. If they do travel it, the traffic counts will reflect this fact. The number of feeder roads will determine the probable amount of future traffic we might expect. All these factors are valuable aids, but in the opinion of the writer, POTENTIAL TRAFFIC is the surest indication of a road's value.

The list of potentials which has been prepared should be watched constantly for changing conditions which would affect the relative importance of each possible road. Traffic patterns are constantly being changed by other roads recently completed or improved; new industries and new school consolidations will affect traffic patterns.

Close contact must be maintained with the Planning Survey for any traffic checks desired on suspicious looking traffic counts or counts which have been questioned by delegations or county officials.

The District Engineer should encourage rather than discourage the many delegations or interested citizens who want to make appointments with him to discuss their pet projects. They may call a meritorious road to his attention which he had somehow overlooked. Then, too, this provides him with an excellent opportunity to explain the whole F. M. plan to groups of people who are more than likely completely ignorant of it. It also provides him with an excellent opportunity to give these people information on the state highway needs - the same "pep talk" he has already given to practically every service club and chamber of commerce in his district.

During this preliminary, or continuing, stage of the selection of projects, he should be trying to analyze the reasons (if he can find any) behind certain requests of county officials for their pet projects. At the same time, these officials should be led, if possible, to sponsor meritorious projects rather than political footballs. I'm not so naive as to believe I can do this very often, but I've even surprised myself on the success I've had on several occasions.

Resident Engineers should be instructed to keep observing the "potentials" in their areas for changing conditions and especially for information which will affect the design or cost of the project if it should ever be programmed.

Such information would include high water observations at important stream crossings and local material sources. Up-to-date estimates on these roads should be maintained with as many breaks as possible for possible partial construction or combinations. It is also advisable to keep up-to-date information on mail and school bus routes.

Let us assume that the District Engineer has kept up with these preliminary steps, that he has been given orders to prepare a program, and has

determined the approximate amounts he will spend in each county. These amounts must necessarily be approximate and will be subject to change from time to time as the work in each county is finally determined. His next step is to prepare a preliminary program of work which he would construct if he were the final authority. He should have in mind acceptable alternates and combinations of alternates. He should avoid becoming too prejudiced on the program he has prepared, but have definite and sound reasons for it. If projects have been selected for the possible program which will terminate at district lines, he should contact the District Engineer of the adjoining district for information as to his intent or willingness to meet the proposed construction in that district.

B. THE FINAL SELECTION OF PROJECTS: Appointments should be made with the first two or three county courts in which proposed projects in one might affect those in the adjoining county. The program can then be decided for these counties, and if the District Engineer has prepared the program carefully, has attempted to "feel the pulse" of the county officials through the months preceding the meeting, has made them feel he is their engineer, he can more than likely sell them the program he has prepared. The District Engineer should use caution at this point and not rush the meetings to a conclusion. He should also guard against being obstinate, should listen open mindedly to every suggestion, and be sincerely sympathetic to the suggestions made for additions.

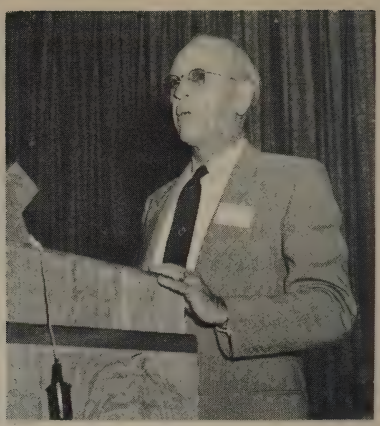
If the county court cannot agree as a unit on the program he has recommended to them, or one of the alternate combinations he is willing to recommend, then he should explain why he will not accept the obviously unworthy projects they are insisting on. This matter of principle is one on which he can and must be firm. Usually, if he has demonstrated an understanding of the Commissioner's viewpoint, and has attempted to distribute projects over the county where near-equal importance of potentials has enabled him to do so, he will secure a unanimous vote of approval of his program, if a vote is desired or requested. If it becomes evident that such harmony doesn't exist, he should leave the court with no definite statement of which projects he will recommend, but from the general discussions which have taken place they will (and should) have a good idea of what the program for them will be. This is not the best way to terminate a meeting, but is some times the only way.

As the meetings with more counties are completed and the funds are more accurately determined in each, it is sometimes possible to readjust projects to the extent of adding a short project in some county where the program had apparently been concluded. This is possible because the accepting of alternates in some counties will alter first one way, then another, the funds required or available for distribution. After all county meetings have been concluded and final adjustments made, the program should be submitted as quickly as possible. In spite of all caution which is given the courts about remaining silent on the subject of possible additions to the system, the news will leak out. The District Engineer will then be plagued by requests from everyone for changes, or roads which are even hard to locate on maps or on the ground. These last-minute requests are never of the same temper as those usually received in the interim period between the forming of programs.

As soon as a work program is submitted to Austin, a new file should be opened for the next anticipated program, and the long-continuing preliminary selection of projects, the list of potentials, observations of conditions affecting the priority of potentials, the schooling of the public, begins a new cycle. This is the stage where proper and diligent effort will make the next program easier to form.

Discussion •

OF G. A. YOUNGS' PAPER



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I am sure that all of us will agree that the paper just presented by Mr. Youngs reflects the fact that he is familiar with the many problems that present themselves in the formation of a Farm to Market Road Program. In discussing his paper I feel that it is natural that I should agree with him on some points and have different thoughts on others. I hope that in this manner some of you will also give your views during the discussion period.

A great many of the districts are getting pretty well along toward the end in the construction of their allotment under the 35,000 mile system. The most needed projects, and therefore the most obvious, have already been constructed or programmed. Also, in the majority of instances, we have in the past picked those roads which were relatively cheap to construct and have bypassed the expensive ones, those having expensive bridge work, for example. It occurs to me that this procedure has been proper, as it has allowed us to build more miles of road in a shorter period of time, which means we have gotten more people out of the mud.

I feel certain that all of the districts have some counties in which practi-

cally all of the county roads with any potential traffic are now hard-surfaced. They are either in the state system or still belong to the county. Naturally, the county officials prefer us to take over and build some of their dirt roads. Nearly all of such roads have about equal merit, which is close to zero, and as a result, good programs are considerably harder to form now than they were a few years back.

I believe that it is proper, and we have followed the practice of deducting from the District Program allotment such funds as are needed to finance necessary work on existing farm roads. As Mr. Youngs has indicated, this should be done before picking new projects. The counties in which these betterment funds are spent should not be penalized in the designation of new roads in the program. County allotments should as far as possible, be based on relative percentages of miles remaining to be built in each county. This is not always easy to follow and in a particular instance, may not be desirable. I have in mind that short project that will be expensive to build. Also, "miles" rather than "dollars," is the measure by which all county allotments are made out of the 35,000-mile state system of farm roads. The counties where construction costs are low don't like this method and would rather have "dollars" distributed than "miles." In the final analysis I believe that regardless of all major considerations, all of us watch the relative money expenditure out of one corner of our eyes in forming a particular program.

It is certainly easier to prepare a program when the process Mr. Youngs calls "continuing programming" is followed. The District Engineer and Resident Engineers should always have a pretty good idea of potential projects. You may even have a list for a future program on file. This works fine until you meet with a court that is not at all certain that the remedy you are suggesting is what is needed to cure their pain.

In meeting with a Commissioners' Court, I have tried to take the part of a listener in order to find out what they want. Before meeting with them, I know approximately how many miles of roads we can build in their county, and in the meeting, prepare a list of projects suggested by them that will total considerably in excess of the mileage that I know we can build. This list should be composed of projects of all sizes. The more different size pieces you have the easier it is to prepare a balanced program and still stay within the district's allotment of funds.

A list prepared in this manner will have roads that are good, bad, and indifferent as far as merit is concerned, but they have one thing in common. They have been suggested by the members of the Court. Naturally, as mentioned by Mr. Youngs, it is desirable in these meetings to discourage the Courts on roads that obviously have no particular merit. Stay out of arguments between County Commissioners as to whose time it is to get a road for their precinct. Make your final decisions on merit.

I doubt the advisability of informing the counties which projects you will recommend or try to get on the program. You may find, when you get through meeting with all of the courts and have digested all of the requests, that certain commitments, inferred or otherwise, will not fit in your overall district program. Also, a recommended program item may be vetoed by the Austin office. This can lead to misunderstanding and ruffled feathers somewhere along the line.

It is certainly necessary for the County Courts and residents of a District to have the fullest confidence in the District Engineer in their area. This confidence can be obtained and held by being absolutely fair in all dealings and by being sympathetic to their troubles and alert to the needs of the district. Under these conditions they will regard you as "their" engineer.